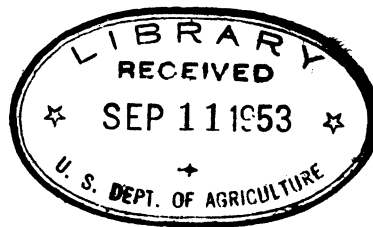


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A Comprehensive Agricultural Program For Puerto Rico,

By Nathan Koenig



United States Department of Agriculture, Washington, D. C.

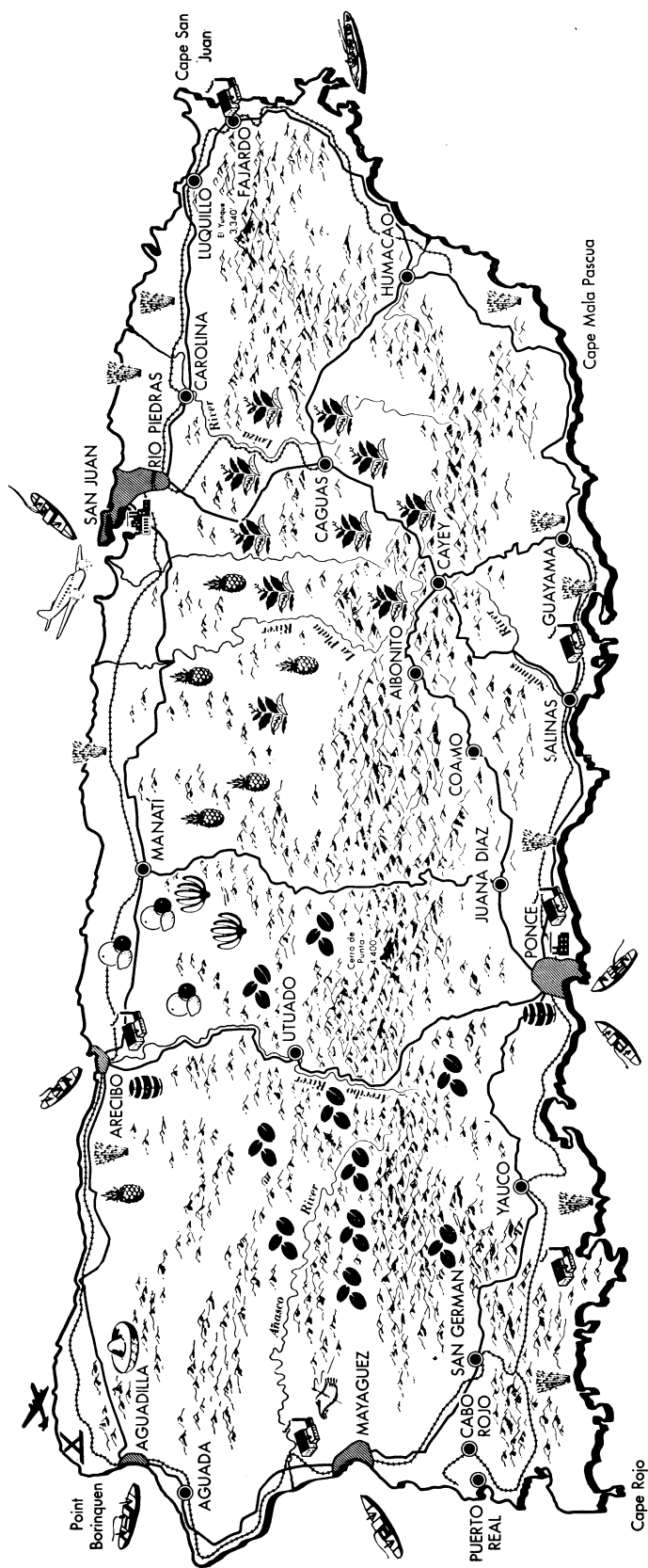
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Puerto Rico: Main Products and Producing Areas



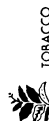
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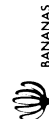
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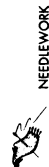
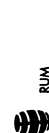
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BANANAS



PINEAPPLE



NEEDLEWORK

Introduction

This is a study of problems of people and their land in an area where both people and land long have been underemployed and also undernourished.

The place is Puerto Rico, where more than 2,000,000 people must live on less than 3,500 square miles of mostly mountainous island. With this population density of about 650 per square mile—one of the highest in the world—it is not surprising that much of the land of this Caribbean island is in need of more care and attention and many of its people are in need of more adequate diets.

In recent years the people of Puerto Rico have made real strides in improving their social and economic conditions. Extensive programs are under way to provide more adequate housing, improve education and health, and raise the general standard of living to a more satisfactory level. Emphasis is being placed on the expansion and development of business and industry to provide more work opportunities for a steadily expanding population. All these measures are being pushed with vigor, and the results are becoming apparent among the people and in the communities in which they live.

Basically, however, Puerto Rico is an agricultural island and agriculture undoubtedly will continue as the backbone of the economy for a long time to come. Hence, it is on the farms that the island's basic economic problems must be met and dealt with.

Following generations of exploitative farming—with production mainly for export—and the growing pressure of a rapidly increasing population, the very limited natural resources have been drained further and further to the detriment of both the people and the land. The evidence of what has happened is reflected in the prevalence of eroded soils, denuded forest areas, sedimented rivers and reservoirs, reduced soil fertility, low crop yields, and an inadequately fed people.

If this condition is to be changed so that the land resources can be improved and made to pro-

duce more, on a sustained basis, for the greater satisfaction and well-being of those who live on the island, obviously there is need for systematic and positive action on a broad front. Agriculture in Puerto Rico must move forward. It must be encouraged to develop and improve along with other parts of the economy to provide the necessary balance and the fundamentally strong base on which economic and social gains on the island must rest if they are to endure.

This study, then, deals with the problems of agriculture in Puerto Rico against the background of the people and their land. With a population continuing its sharp increase beyond the 2,211,000 shown by the 1950 census, this relatively small island will remain one of the most densely populated areas of the world. Since the days when Puerto Rico was first settled by the Spanish colonizers, the people have experienced a constant struggle which basically has centered around getting enough to eat. The problems now under attack are thus deeply rooted in the events and actions of the past.

In an analysis of the Puerto Rican population structure, the study concludes that the present situation of the people is a measure of the adjustments still needed to achieve the goal of a decent standard of living. The problem must be attacked where it is most acute—in the rural areas where the general level of income and conditions of living are lowest, where essential facilities for education and other social needs are sorely lacking, and where the birth rate is among the highest in the world. Emphasizing the need for narrowing the wide gap in economic and social well-being that now exists between the rural and urban areas of the island, the study points out that this must be achieved, not by doing less in the towns and cities but by doing more of consequence for and in the country places.

Reviewing the economic development of Puerto Rico over a period of more than four centuries, the study shows widespread underemployment of

both human and land resources. The fundamental weakness of the economy is revealed in the fact that both agricultural and industrial production have had their focus primarily on the export market and continue to overlook the real possibilities of the local market. This results in a heavy reliance on imports of many kinds of farm and factory products which otherwise could be produced economically in Puerto Rico. The study points out that if the economic base of the island is to be effectively broadened and strengthened, it is essential that far more attention be given to diversifying and increasing production for local needs to the full extent that it is economically feasible while at the same time maximizing economic production for export.

While agriculture, directly or indirectly, provides about 40 percent of Puerto Rico's total net income, the mainstay of the economy is the growing of sugarcane and the production of sugar. More than two-fifths of the total cropland and most of the best soils are planted to this single crop from which is derived a little more than one-half the value of farm production. The study shows that the commercial uses of land in Puerto Rico have long been governed and influenced by various factors, the most important of these being (1) the availability of capital and credit, (2) the existence of protected markets, (3) the availability of factories or processing plants, and (4) the existence of transportation and marketing facilities. Throughout the history of the island nearly all these factors, at one time or another, favored the production of certain export crops such as tobacco or coffee, but always favored sugar.

The study reveals that much land in Puerto Rico is not being utilized to the best advantage. There has been considerable misuse, neglect, and waste of the soil and water resources on which the economy must so heavily depend. Nearly one-half the land area already has 75 percent or more of its topsoil removed by erosion. Besides the land itself, water is the most valuable of the very scant natural resources on the island. The study points out that the conservation of Puerto Rico's soil and water resources, for sustained productive use, is an undertaking of vital concern to the local people in all walks of life. A number of measures are suggested to encourage the improvement of farming practices, halt erosion, raise soil fertility, and protect watersheds.

The study shows that Puerto Rico has around 600,000 acres of land which, because of excessive slope, heavy rainfall, or shallow, infertile, or poorly drained soil, cannot be cultivated or pastured continuously without soil deterioration or very low yields, but which can produce trees as a permanent crop. More than one-half this acreage, however, is bare of any protective tree cover while most of the land in tree crops such as timber, fuel wood, coffee, fruits, etc., is in such poor condition that it contributes little to the economy. More than a century ago Puerto Rico reached a point where it was no longer self-sufficient in forest products. As a result, at least 80 percent of the wood and wood products consumed locally are imported. The lack of forest cover has jeopardized agriculture in many parts of the island and contributed heavily to lowering soil permeability and increasing surface runoff. The resulting erosion has also speeded up the sedimentation of streams and reservoirs needed for hydroelectric power, irrigation, and for industrial and domestic water supply.

The study indicates that intensified efforts are required to educate the general public, particularly landowners, to the need for proper use and management of local forest land resources. The importance of improving the growing of coffee and the need for additional research on specific cultural and management problems are emphasized. Also suggested is a system of Government incentives to private landowners to encourage protective and productive forestry on at least 175,000 acres of forest land. The study points out that Government should acquire, improve, and manage as public forests those large blocks of critical forest lands the protection of which is of greater concern to the public as a whole than to individual landowners. It is proposed that not less than 101,000 acres of forest land included in 14 concentrations should be publicly acquired during the next 10 years. After acquisition, this land could provide permanent subsistence farms for about 1,250 families without hindrance to the objectives of public forest multiple-use management.

One of the great and most promising potentials for increased agricultural production in Puerto Rico is revealed by the study to be in the improvement of grasslands to produce pasture and other grass crops for livestock feeding. Altogether, the island has about 664,000 acres of land well suited

for pasture and forage crops. The study shows that the productivity of much of this grassland could be doubled and even tripled simply by the use of such pasture improvement practices as liming, fertilizing, reseeding, and the adoption of better grazing systems and more efficient management of the improved grasses and legumes. This would permit a considerable expansion in livestock production, especially in dairying, and thus produce a far greater economic return than is now being obtained from the same land. It is proposed that vigorous steps be undertaken to focus the attention of farmers on the economic potential of their grasslands and to help them apply measures to increase pasture and forage production and utilize effectively the total output for livestock feeding.

In a further analysis of Puerto Rico's agricultural potentials, the study shows that with improved production techniques and some shifts in land use the island could have a more diversified and highly productive agricultural industry. Since the amount of land available for farming is definitely limited, the main hope for raising the level of agricultural output lies in obtaining economically higher yields from each acre and from every unit of livestock. An attainable production pattern designed to make more effective use of farmland resources with no more than a reasonable change in present farming methods is proposed. The production of sugarcane, for example, would be continued at the maximum permitted by the quota under the Sugar Act, but through improvement of per-acre yields by means already at hand 25 percent less land would be so utilized. Under the production pattern as proposed, the farm value of agricultural output, computed on the basis of 1950-51 prices, would be almost three-fourths greater than the farm value of the same commodities actually produced in Puerto Rico in 1950-51. The farm value of livestock products, including milk, eggs, meat, and chickens, would be raised by 145 percent while the value of crops exclusive of sugarcane would go up by 171 percent. Such an attainable production pattern, it is indicated, would enable Puerto Rico to cater to the demand that exists or which could be developed in the *total* market, both within and outside of the island. It would provide more income for more people and also more food for all the population.

The study shows that the proposed attainable production pattern would yield enough food to meet the requirements of a low-cost adequate diet for a population of 3,000,000 and permit some reduction from the high volume of food imports received for the island's 2,211,000 population in 1950-51. In that year the people of Puerto Rico had available from local production and imports only 939 pounds of food per capita as against an annual requirement of 1,344 pounds for a low-cost adequate diet. About 45 percent of the food that was available in 1950-51 came from imports and the balance was locally produced. It is estimated that the proposed attainable production pattern could be achieved with reasonable local effort within a period of 10 to 15 years, provided more adequate credit is available to farmers and necessary improvements are made in the system of marketing and distributing agricultural products. Once achieved, it would enable Puerto Rico to become much less dependent on food imports than is now the case and at the same time would permit export shipments of farm products, such as sugar, pineapples, tobacco, and others, in the maximum amounts that could be absorbed by outside markets with reasonable returns to Puerto Rican producers.

In the field of agricultural credit, the study shows that a long-standing lack of adequate financing for almost any agricultural enterprise outside of sugarcane growing has kept farmers in Puerto Rico from expanding existing farm operations or engaging in new production. The annual need for production credit alone is estimated at between 90 to 100 million dollars. Of this, a total of around 44 million dollars is being supplied by established lending agencies such as private banks and governmental sources. While part of the 46-million-dollar difference is being handled by merchants and other such lenders, the study indicates that this total amount represents business that very well could be taken up by the regular credit agencies with profit to themselves and substantial savings to farmers. In addition to a reexamination of lending policies, the study suggests that private banks in particular establish agricultural credit departments staffed by personnel trained in agriculture and finance. The study also urges that serious consideration be given to organizing under Federal law a second production credit association. It points out that the amount of sound agricultural credit business already and potentially

available on the island warrants better service and more constructive competition in this lending field. To meet sound financing needs, especially those of small farmers, the study stresses the importance of organizing credit cooperatives. An amendment to the law governing the operations of the Puerto Rico Bank for Cooperatives is suggested in order to increase this agency's capital for the purpose of encouraging more agricultural credit cooperatives under a system of adequate credit supervision for individual borrowers. Expansion in Puerto Rico's crop-insurance program with reinsurance under the Federal Crop Insurance Act is also urged as an important adjunct to necessary improvements in the island's agricultural credit system.

Of paramount importance to the development of agriculture in Puerto Rico and increasing the local food supply are the improvement of the marketing system and the establishment of adequate facilities for handling and utilizing farm products. The study points out that, except in the case of the island's sugar industry, the functional aspects of marketing and the organizational structure needed to serve both producers and consumers have received scant attention. A properly functioning marketing system should act like a suction in drawing production off the farms into the various channels of use and consumption. By giving full expression to the demand that exists for the various products in the different outlets, such a marketing system would provide the incentive for maximizing local production and afford facilities for complete utilization and orderly distribution of the total output. Instead, however, the many shortcomings that prevail have had the opposite effect. The limitations inherent in the present marketing system have not only narrowed the opportunities for farmers but also deprived consumers of large quantities of food and other agricultural commodities which could be produced locally. The resulting lack of those incentives which a properly functioning marketing system could provide has prevented desirable diversification of agriculture in Puerto Rico and actually resulted in a level of production lower than that which is warranted by the available resources.

The study proposes a number of measures for improving the marketing and utilization of farm products and for increasing the efficiency of distribution. It urges that the central market facil-

ity recommended by an earlier study be constructed in the San Juan area without delay since existing facilities in this hub of marketing and distribution are wholly inadequate. Unless improved facilities are provided, there is little hope for increasing the efficiency and lowering the cost of food distribution on the island, or for attaining the market incentive that farmers need to produce more for local consumption. Private individuals and groups should be stimulated to invest in improvements or construction that will modernize and increase the efficiency of such enterprises as retail food outlets, processing plants, slaughterhouses and packing plants, and provide other facilities needed for properly utilizing agricultural products and byproducts. Strengthening cooperative organizations and developing new cooperatives with able management to provide marketing and other services to farmers are listed as urgent needs. Among the necessary improvements in marketing practices and methods are establishing grading and packing standards for farm products, standardizing containers, extending market news, crop reporting and inspection services, and improving communication and transportation facilities. The study emphasizes the importance of developing new and improved uses for Puerto Rican farm products and suggests the establishment of an agricultural processing pilot plant for such developmental work. In terms of specific commodities, a number of suggestions are made for improving the marketing of milk, livestock and meat, sugarcane and sugar, pineapples, and tobacco.

While industrial development in Puerto Rico is being helped by various forms of tax incentives, the study points out that no such attention or treatment has been accorded to agriculture. Tax policy in Puerto Rico must recognize the island's need for building up its agricultural plant and the allied facilities and services required to process, handle, and distribute the various products from the time they leave the farm until they reach the consumer. The tax policy in effect for so many years has been of little help to the development of a diversified agricultural industry on the island. The study suggests a number of changes in the present tax structure, including a system of income-tax credits, and tax exemptions to encourage investments in construction, improvements, or installations for developing the production, proc-

essing, or handling and distribution of agricultural products. Also suggested is the removal or modification of certain excise and other taxes which in one way or another have the effect of restricting production, slowing down or limiting distribution, or retarding consumption of Puerto Rican agricultural products.

In an analysis of the pattern of land tenure in Puerto Rico, the study stresses the need for moving forward with a land policy that will improve both the distribution and utilization of the land. Although congressional and local legislative enactments have prescribed a land policy for the island, additional decisions are needed. The study points out that the long-run approach to the land problem should concern itself more with the need for expanding production on a broad front rather than with attempting to cater primarily to any immediate employment situation. It suggests that the family-type farm, of a size adequate for the productive use to which it is to be put, deserves special consideration in the development of agriculture in Puerto Rico. To the extent that family-type farms are found to be desirable as a means of maximizing and diversifying production and improving rural living, they should be encouraged to the fullest degree possible.

Since a great deal of land in Puerto Rico is still concentrated in the hands of a relatively few owners, the study urges that the program of divesting corporations of land holdings that are in violation of the 500-acre limitation be carried to completion by the Land Authority. In addition, other large holdings should be acquired whenever it is possible in order to improve the utilization and distribution of such land. All such land should be made available to promote more widespread individual ownership of economic farming units. The study suggests the need for a thorough examination of the operations of all the Land Authority's proportional-profit farms which have operated at a loss producing sugarcane. The contribution of these farms to the economy of the island probably could be increased by emphasizing diversified production in-

stead of growing sugarcane alone. Otherwise, it might be desirable to subdivide these farms for disposal as family-type farms. On those proportional-profit farms which are profitable producers of sugarcane, the Land Authority should be able to concentrate on further improving the production of this crop and at the same time move to diversify their agricultural operations so as to lead the way for other large farm operators. Pointing out that there is no particular virtue in a governmental agency farming land if the same results can be achieved through private initiative, the study indicates that the long-run objective should be for the Land Authority to get out of its present role of being in control of substantial acreages of agricultural lands. One of the first aims should be to give more impetus to the family-type farm. But this need not preclude the possibility of opening for farm families an opportunity for land ownership and operation through the medium of cooperative action. In fact, the desirability of such a course might well be determined by converting one of the proportional-profit farms into a bona fide cooperative enterprise that would be owned and controlled by the members themselves who also would work on the farm. The study emphasizes that whatever is done to improve land tenure, agricultural progress must depend primarily on the farm family and its sense of pride in farm ownership and accomplishment on the land.

The total of what is suggested by this study constitutes a comprehensive agricultural program that charts a course of action in the many problem areas but leaves to those who would be responsible for its execution freedom for the exercise of initiative and the flexibility needed for determining in detail how it shall be carried out. To achieve the desired aims will require full and effective cooperation from all participants and proper coordination and integration of all the measures and efforts to be employed. The success of such a program can only be measured, of course, by what is actually accomplished on the land and among the people themselves.

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The work of many people went into this study. Without their generous assistance and cooperation this publication would not have been possible.

The development of a comprehensive agricultural program for Puerto Rico was advanced in July 1950 by Governor Luis Muñoz Marín in a request to Secretary of Agriculture Charles F. Brannan suggesting that it be undertaken jointly by agencies of the Government of Puerto Rico and the United States Department of Agriculture. During the little more than 2 years required to complete this study, about 100 technicians living and working in Puerto Rico gave unstintingly of their time and best thinking to this project while performing their regular duties as employees of their respective agencies. Their work was carried on through 14 task forces, each responsible for dealing with a particular phase of Puerto Rican agriculture and rural living. The information and recommendations developed by these task forces formed the basis for this publication. In all of this undertaking, great reliance has been placed on the practical experience of men and women in Puerto Rico, including agricultural leaders, businessmen, and others.

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NATHAN KOENIG,

*Assistant to the Secretary of Agriculture,
United States Department of Agriculture.*

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Contents

	Page		Page
CHAPTER I			
THE PEOPLE AND THE LAND.....	1	3. Domestic and Industrial Water Supply.....	83
CHAPTER II		Ground Water Resources.....	87
THESE ARE THE PEOPLE.....	5	Water Rights and Concessions.....	89
Age Composition.....	6	4. Water Pollution.....	90
Birth, Marriage, and Death Rates.....	7	Action Taken to Control Pollution.....	91
The Course of Migration.....	9	Problems and Needs to be Met.....	93
Cultural Characteristics.....	11	5. Flood Control.....	94
Education and Literacy.....	12	6. Drainage.....	95
The Labor Structure.....	14	7. Wildlife and Recreation.....	97
The Picture on Income.....	17	Count of Waterfowl and Doves.....	98
Rural Living Conditions.....	19	Hunting and Kill Data.....	98
Level of Nutrition.....	22	Feeding Grounds Need Development.....	99
The Score at Present.....	24	Commercial Marine Fisheries.....	100
CHAPTER III		Inland Fishery Resources.....	100
THIS IS THE LAND.....	27	CHAPTER VI	
Puerto Rico Under United States Sovereignty.....	29	LAND FOR FORESTS AND TREE CROPS.....	103
Agriculture's Role in the Economy.....	31	The Forest Lands and Their Condition.....	103
Land Tenure and Usage.....	32	Forest Resources Abuse and Its Results.....	105
Emphasis on Production for Export.....	36	Need for Education and Research.....	107
The Depression Squeeze.....	36	Strong Public Leadership Required.....	111
First Moves Toward Recovery.....	37	Public Acquisition of Forest Land.....	112
A New Era and World War II.....	39	Forestry Incentives for Landowners.....	116
Postwar Developments.....	41	Recreation, Wildlife, Community Forestry.....	117
Lack of Economic Balance and Diversity.....	42	CHAPTER VII	
CHAPTER IV		UTILIZING GRASSLAND RESOURCES.....	119
THE PROBLEM OF SOIL EROSION.....	45	Land for Pasture and Forage.....	121
Present Condition of the Soil.....	45	Pasture Improvement With Legumes.....	123
Soil Fertility and Fertilizers.....	48	Use of Pasture Supplements.....	127
Soil Organic Matter.....	49	Grasslands Management.....	129
Cultivation of Sloping Land.....	50	Grasslands Research and Education.....	133
Sugarcane Problem on Slopes.....	51	CHAPTER VIII	
Sedimentation of Reservoirs.....	54	DEVELOPING NEW LAND BY RECLAMATION.....	137
Beach Erosion.....	58	Tiburones Drainage Project.....	138
Soil Conservation Districts.....	58	Loíza-Río Grande Drainage Project.....	139
Conservation Education and Information.....	61	Lajas Valley Development Project.....	140
Research Basic to Conservation.....	63	La Regadera and Coamo Projects.....	146
CHAPTER V		Other Areas for Study.....	148
USE AND CONTROL OF WATER.....	65	CHAPTER IX	
1. Irrigation.....	67	AGRICULTURAL CREDIT AND FINANCE.....	151
South Coast Irrigation District.....	68	Sources of Agricultural Financing.....	152
Isabela Irrigation Service.....	70	Interest Rates and Credit Costs.....	158
Additional Areas for Irrigation.....	71	Amount of Credit Required.....	160
Overall Problems in Water Management.....	73	Ways to Improve Credit Sources.....	164
Focal Points for Action.....	76	Credit Education and Supervision.....	170
2. Hydroelectric Power.....	78	Legal Obstacles in Agricultural Credit.....	172
Rural Electrification.....	81		

CHAPTER X

POTENTIALS IN AGRICULTURAL PRODUCTION.....	175
Technology in Farming.....	176
The Present Pattern in Agriculture.....	181
The Existing Dependence on Imports.....	184
Food Requirements and Actual Supply.....	187
Improving the Balance in Agriculture.....	190
More From the Land, More For the People.....	214

CHAPTER XI

MARKETING FARM PRODUCTS.....	219
Some Overall Marketing Needs.....	224
Milk Marketing and Distribution.....	230
Marketing Livestock and Meats.....	233
Marketing Sugarcane.....	235
Marketing Pineapples.....	240
Tobacco Marketing.....	243

CHAPTER XII

LAND AND TAX POLICIES.....	247
The Shaping of a Land Policy.....	247
The Land Law of Puerto Rico.....	250
Operations of the Land Authority.....	252
Land Policy and the Land Authority.....	257
Tax Policy and Agriculture.....	262

CHAPTER XIII

PULLING TOGETHER FOR A STRONGER AGRICULTURE.....	271
The Local Department of Agriculture.....	273
Strengthening Extension Work.....	274
The Experiment Station's Role.....	277
Formal Education in Agriculture.....	279
Overall Program Needs.....	284
BIBLIOGRAPHY.....	287
INDEX.....	291

Chapter I

The People and the Land

When Puerto Rico was first settled by Spanish colonists shortly after its discovery by Columbus in 1493, much of its land, despite the ruggedness of the interior, was good land. But during most of the more than four centuries since that time people have not been good to it.

Only in recent years has there been a real awakening to this fact. And even today, after the many reforms that have taken place in the island's economy, the land—exploited more than farmed—affords only a bare subsistence for a great part of the population.

Mining of the island's natural resources began with the early colonists' search for gold but soon shifted to the soil itself. This turn in the search for treasure came within 20 years after the influx of the Spanish colonizers, when the glitter of gold virtually faded from the island's mountainsides. It marked the start of an agriculture based on the exploitation of land and people.

The kind of agrarian economy that developed, and that prevails now, concentrated on production for export. The soil yielded generously of its fertility but there was little or no replacement of what was taken out by continuous cropping. Absentee ownership of large blocks of the best land got off to an early start. For a long time the agriculture of the island depended on slave and cheap labor. The slaves were liberated in 1873 but low-paid labor has persisted. Only the poorer soils in the mountainous areas became available for tilling by individual small farmers.

As the population of the island increased, agricultural production expanded. People came mostly from Spain but also from other countries; they settled down and multiplied. And the soil

continued to give up its fertility to support the growing numbers of people.

Between 1765 and 1812, the population of Puerto Rico increased from nearly 45,000 to about 183,000. By 1830 the island had nearly 324,000 people, and this figure was more than doubled by 1867. A year after Puerto Rico was separated from Spanish rule and came under the sovereignty of the United States, the census of 1899 showed a total population slightly in excess of 953,000.

By the time the United States obtained sovereignty over Puerto Rico, absentee landownership had a firm hold on the economy. The fertile lands along the coastal plain and the more productive lands of the mountain areas were tied up in large blocks. From these holdings came the great bulk of the sugar, coffee, and tobacco which had developed into the main export crops. The economic pattern was such that the island was heavily dependent on imports for much of its food and for virtually all manufactured and processed goods. The land showed marked effects of the constant draining away of the soil's fertility by the system of exploitative farming that had become so solidly established. Vast forest areas had been destroyed and the removal of the protective cover from the steep slopes had bared the topsoil to the pounding forces of the heavy tropical rains. Both soil erosion and human erosion were well under way.

Under the American flag, Puerto Rico received the advantages of the United States market, and investment capital flowed from the States along with certain technical know-how. The pace of a hoe-and-machete economy was quickened, and there was plenty of labor to keep these two hand



Symbols in an economy: The hoe and the machete.

tools swinging. Agriculture on the island expanded, but still for the export market. Public health measures were introduced and improvements made in various facilities. Life expectancy increased and so did the population total.

Over a period of about 30 years the economy of Puerto Rico seemingly hummed with activity. Then the forces of nature and economics combined with devastating effect on the island. Two hurricanes and the world-wide depression brought a virtual collapse. By this time the population of Puerto Rico approximated 1,544,000, a gain of over 590,000 since the first United States census on the island in 1899. An era of large-scale Federal relief and rehabilitation activity set in to alleviate the wholesale suffering and want that stemmed from the collapse. However, some of the things done were as effective as pushing on a rope, for the fact remained that the available resources and the manner of their utilization had already been outstripped by the rapid rise in population. The race was on. Between 1930 and 1940, the number of people in Puerto Rico increased another 21 percent to a total exceeding 1,869,000.

The outbreak of World War II and the rise of

a dynamic and enlightened political leadership on the island brought tremendous changes to this stricken area. The war put new life in the demand for Puerto Rico's export crops, especially sugar. Agriculture on the island responded to meet the needs of the war and post-war years. At the same time, the internal political leadership that had steadily developed gained popular support with a positive program for the improvement of social and economic conditions.

In 1948, as the result of legislation enacted by the United States Congress, Puerto Rico was able to elect its own first governor. This marked the beginning of local government directly responsible to the people of the island. Under this government, bold action has been taken to develop the economy and improve living conditions. Much emphasis has been placed on the establishment of new industries and the development of tourism. Progress is reflected in increased business activity and a higher level of employment with improved buying power. The gains are striking indeed, considering the point from which the start was made.

But the picture is not as bright as it appears on the surface. All of the efforts exerted to expand

industry and business are being diluted by the continuing high increase in population. The 1950 census showed that the population of Puerto Rico had risen to about 2,211,000, an increase of almost one-fifth in 10 years. Thus the pressure of population against resources in Puerto Rico has been rapidly growing more and more intense. Too many people on too little land—that is the crucial problem this island is up against.

Physically, Puerto Rico is about 1,600 air miles southeast of New York City and 1,065 miles from Miami. The island is the most easterly of the Greater Antilles, situated between $17^{\circ}55'$ and $18^{\circ}31'$ north latitude and $65^{\circ}39'$ and $67^{\circ}15'$ west longitude. It is bound by the Atlantic Ocean on the north, the Caribbean Sea on the south, the Virgin Passage on the east and the Mona Passage on the west. The island stretches east and west to a maximum length of 113 miles, with an average width of 41 miles. The total area approximates 3,435 square miles. Around the coast is a narrow fertile plain which rises gradually toward the interior, in a series of mountainous ranges that oc-

cupy the major portion of the island's surface. The highest ranges rise to around 3,000 feet, the highest peak reaching 4,398 feet. These mountains run mostly from east to west and are broken by intervening deep, narrow valleys.

The topography of the island causes great diversity of beauty, soil fertility, and climate. Because of the mountains, there is a difference of 173 inches in yearly rainfall between the northeast and the central south, a distance of only 69 miles. The average rainfall is around 60 inches for the northern coastal plain, 30 inches for the southern plain and 100 inches for the mountain region. Temperatures show far less variations. Being so far out at sea, Puerto Rico receives in full measure the trade winds which blow almost constantly from the northeast. This continued flow of breeze is the secret of the island's ideal climate, which varies from tropical to subtropical. The mean January temperature for the island as a whole is 73° F. and the mean July temperature is 79° , a range of only 6° . The coolest areas, of course, are in the mountain regions and the warmest in



Puerto Rico's location with respect to the United States mainland, other islands in the Caribbean, and Central and South America

the lowlands, but the differences average only about 8° throughout the year. At no time has an official thermometer recorded a temperature below 39° nor above 103° in any part of the island. Temperature recordings over a period of more than 30 years show a range from a minimum of 44° to a maximum of 94° for the interior of the island at Cayey, a minimum of 55° and a maximum of 96° for the southern coastal plains and foothills at Ponce, and a minimum of 62° and a maximum of 94° for the northern coastal area at San Juan.

In spite of its small size, Puerto Rico is a land

of contrasts. Within its limited and crumpled territory there are 115 soil series with 352 different types and phases of soil; there are 7 distinct areas of rainfall, ranging from more than 200 inches in the northeastern mountains to less than 30 inches in the southwestern coastal plain.

The physical portrait of Puerto Rico has long been beclouded by dramatic developments. These have cast their shadow in the past with serious consequences. They now shade the future—and with an intensity that will not diminish until it has given rise to a human concern fully responsive to the great needs of both the people and the land.

Chapter II

These Are the People

On a land area only about 3,420 square miles, Puerto Rico has a population total that makes this island one of the most densely populated areas of the world. It is exceeded in this respect only by two of the highly industrialized countries of Western Europe, namely, England and Belgium. In this hemisphere, the most densely populated independent country is Haiti, which has a population density only half as great as Puerto Rico's.

There were approximately 645 persons per square mile in Puerto Rico in 1950, according to the census, which reported 2,210,703 inhabitants on the island as of April 1 of that year (table 1). In the same year there were only 50 persons per square mile on the mainland of the United States. The greatness of this contrast becomes apparent when it is realized that if the continental United States had the same density of population as Puerto Rico, the population of the mainland would have exceeded 1,900,000,000 in 1950, as against the actual total of around 151,000,000. And, if at the same time all the natural resources—oil, coal, and

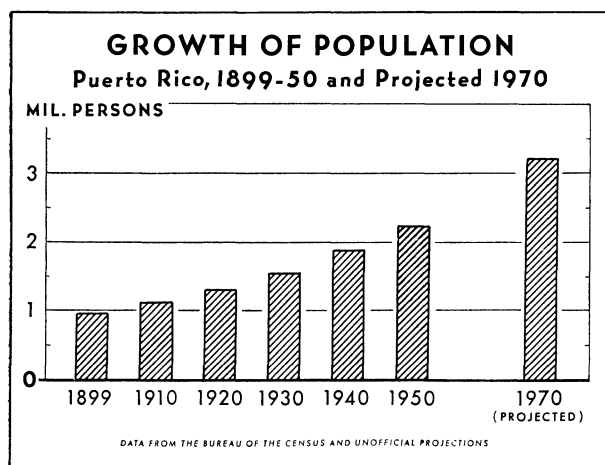
minerals—and most of the industrial plants of the United States were by some magic removed, then conditions respecting both population density and resources would be roughly comparable to those existing today in Puerto Rico.

The crux of the so-called Puerto Rican population problem lies in the fact that Puerto Rico has a highly agricultural economy. Practically all the other countries of the world with a comparable density of population are urban-industrialized countries. Because of an almost complete lack of mineral and fuel resources, because of its history and traditions, and because of its late entry on the industrial scene, Puerto Rico most likely will never become as highly industrialized as these other areas. So the island undoubtedly will continue to depend heavily on agriculture; and its million-or-so acres of land that can be farmed (less than 50 percent of the total land area is tillable) will in some manner have to be stretched to accommodate the rapidly mounting population burden.

Table 1.—Population of Puerto Rico and average annual rates of increase, 1899 to 1950 ¹

Census date	Total population	Population increase over preceding census		Average annual rate of increase
	Number	Number	Percent	Percent
1899 (Nov. 10)-----	953, 243			
1910 (Apr. 15)-----	1, 118, 012	164, 769	17. 3	1. 54
1920 (Jan. 1)-----	1, 299, 809	181, 797	16. 3	1. 56
1930 (Apr. 1)-----	1, 543, 913	244, 104	18. 8	1. 69
1940 (Apr. 1)-----	1, 869, 255	325, 342	21. 1	1. 93
1950 (Apr. 1)-----	2, 210, 703	341, 448	18. 3	1. 69

¹ Data from Bureau of the Census.



The population of Puerto Rico has been increasing steadily and at a high rate for a long time. Since the turn of the present century the number of people on the island has about doubled within a 40-year span. Available projections indicate a continuance of this trend.

This problem promises to grow more serious each successive year. Available population projections indicate not only that the population of Puerto Rico will continue to grow but also that future growth may continue to be rapid.

In 1945, a Puerto Rican demographer, José L. Janer, fitted a (logistic) curve to the available data for earlier years. The 1950 census population differs by only about 25,000 from the figure which could have been predicted by this curve. The correspondence of these 1950 figures with the earlier projections tends to add weight to the possibility that this curve represents a reasonable description of the trend of population growth. The figure for 1970 projected from this curve is 3.2 million, implying an average annual rate of increase between 1950 and 1970 of 1.9 percent. Other projections based on conservative assumptions (an average rate of natural increase of 2.1 percent

and an average annual emigration of 6,300) indicate approximately the same population for 1970—3.1 million. This figure represents a doubling of the population in the 40-year span from 1930-70.

Age Composition

Puerto Rico's population is relatively young and, unlike the population of the United States and other western countries, its median age is almost stable. In 1950, the median age (the age above and below which one-half of the population falls with respect to age) in Puerto Rico was about 18 years (table 2); the median age of the United States population was about 30 years. In 1900 the corresponding figures were 18 and 23 years.

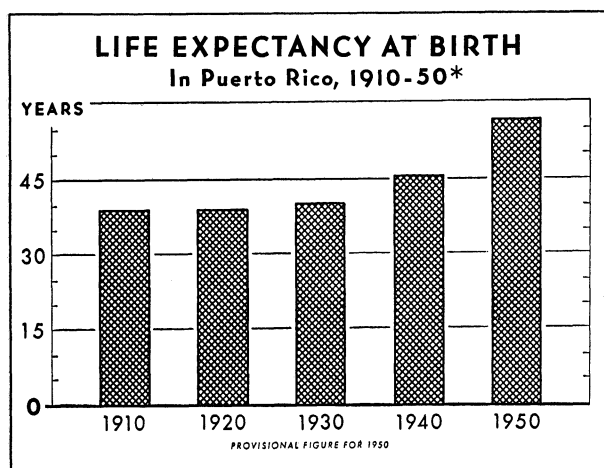
The death rate (deaths per thousand population) has been generally declining in the last half century in Puerto Rico, and this trend has become more pronounced during the last few decades. At present the death rate in Puerto Rico is about at the levels which characterize the more advanced countries. In 1900, the death rate stood at about 27; in 1949, the rate was about 11 per thousand—a decline of almost 60 percent and continuing downward. The United States rate fell only 40 percent in the same period, from about 17 to 10 per thousand.

The most striking declines in mortality have occurred among the older children (those 5 through 19) and among mothers, but even the aged groups have shared in the gains. As a result of these pervasive declines in mortality, a constantly increasing percentage of the population has reached adulthood and middle age. The expectation of life at birth has increased substantially, from 38 years in 1910 to 56 years in 1950. However, although continuing to rise, it is still considerably below the United States level of about 68 in 1950.

Table 2.—Percent distribution of population by age for Puerto Rico, 1899 to 1950¹

Age	1899	1910	1920	1930	1940	1950
	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Total, all ages.....	100.0	100.0	100.0	100.0	100.0	100.0
Under 15 years.....	43.9	43.0	43.3	42.1	40.6	43.2
15 to 19 years.....	9.8	10.2	9.7	12.1	11.0	10.0
20 to 44 years.....	34.4	34.8	34.0	33.0	34.4	31.9
45 to 64 years.....	9.7	9.7	10.6	10.4	10.4	10.9
65 years and over.....	2.1	2.3	2.4	2.5	3.4	3.9
Median age.....	18.1	18.5	18.4	18.3	19.2	18.4

¹ Data from Bureau of the Census.



The expectation of life at birth has risen considerably in Puerto Rico, from 38 years in 1910 to 56 years in 1950. The most substantial increase took place in rather recent years largely because of an expanding public health program which is continuing to whittle down the death rates among all age groups.

Indications are that, as long as an expanding public health program is in operation, the benefits of which are made generally available, death rates at each age will continue to decrease and the expectation of life at birth will continue to increase. These trends may be reversed, however, if levels of living should become extremely depressed as a result of a considerable increase in population density and the failure to make more effective use of all available resources on a sustained basis.

Birth, Marriage, and Death Rates

In 1899-1910 there were about 40 births per thousand population; the corresponding number in 1949 was 38. The latter figure may be compared with 24 for the United States. In Puerto Rico, birth rates are considerably higher than in the United States for each and every age of mother; childbearing begins at a younger age and persists to a considerably older age than in the United States and other western countries. It would seem that a sizeable number of women continue to bear children right up to the time when they are no longer capable of conceiving them. The tabulations of the 1950 census of Puerto Rico indicated that the average woman 45 years of age and over who was ever married had given birth to 6 children during the course of her childbearing period. The corresponding figure for the United States was probably only about one-half of that.

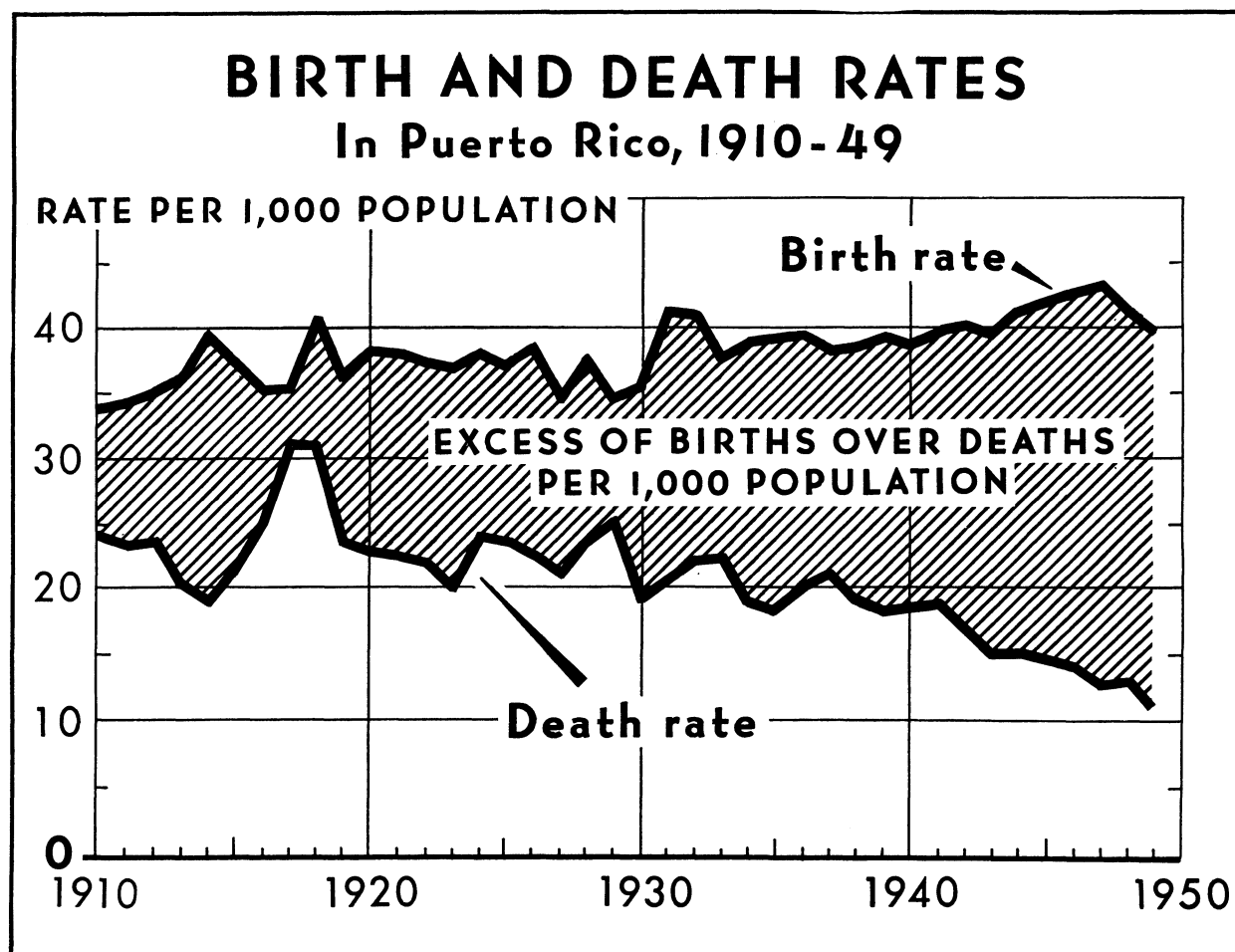
Moreover, the biggest source of Puerto Rico's

population increase is in the rural areas. Census figures for 1950 indicate that the average married rural woman 45 years of age and over had given birth to about 7 children during her childbearing period, compared with about 5 children for women in urban areas. Also significant is the fact that 29 percent of the rural women had given birth to 10 or more children, compared with 16 percent for urban women. Births of from 4 to 7 children per mother during the childbearing period show little variation between rural and urban women. But, about 29 percent of the urban women gave birth to 1, 2, or 3 children during the childbearing period, as compared with 16 percent of the rural women. And while only about 6 percent of the rural women had no children born during their childbearing period, approximately 11 percent of the urban women were in this category.

An important factor in the maintenance of the high level of the birth rate during the decade between 1940 and 1950 has been the high marriage rate during this period. The high marriage rate is reflected in the fact that the number and percentage of married persons on the island were at their highest in 1950. Of the population 14 years old and over, 56 percent were married, compared with 52 percent in 1940 and only 45 percent in 1900. Also, the percentage married, especially for females, tends to be higher in the rural areas than in the urban areas.

The rapidly declining mortality, coupled with the almost stationary high birth rate, has made the population of Puerto Rico one of the fastest growing populations in the world at present. The rate of natural increase (the difference between births and deaths per thousand population) is a measure of the current net addition or loss to a population through births and deaths. This figure for Puerto Rico in 1899-1910 equalled 15 per thousand population and by 1950 it had almost doubled (26 per thousand population). In the United States the 1950 rate of natural increase was approximately 14—about the same as it was in 1900 and roughly the figure for Puerto Rico in 1900. In the States, both the birth rate and the death rate have shown a net decline since the early part of the present century.

Potentially, the population of Puerto Rico could increase at a far higher rate than is now the case. The extent is indicated by the gross reproduction rate which is a measure of the potentialities for



Mortality has been declining rapidly in Puerto Rico while the birth rate has remained at a high level. This has resulted in a rising rate of natural increase in the island's population.

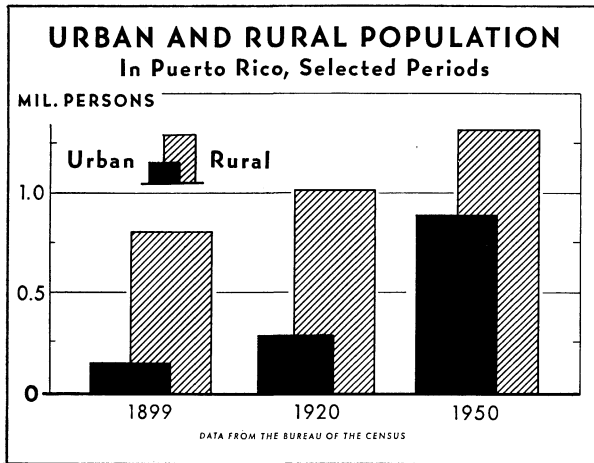
population growth if current birth rates remain unchanged indefinitely and no allowance is made for mortality; a rate of 1.00 means that the population will just about replace itself in a generation. The gross reproduction rate, like the crude birth rate, remained unchanged in Puerto Rico from 1900 to 1950, at a level approximating 2.50; this means that at current birth rates the population of Puerto Rico could, potentially, more than double in a generation.

The net reproduction rate, which, unlike the gross reproduction rate, allows for mortality up through the childbearing period (on the assumption that prevailing death rates remain unchanged indefinitely), showed a steady and rapid increase in the last 50 years, from 1.43 in the period 1899-1910 to 1.80 in 1947. The increase in the net reproduction rate reflects the effect of improvement in mortality. Thus, in 1947, Puerto Rico

had a net reproduction rate unsurpassed by any Occidental country.

Since communicable diseases (diarrhea and enteritis, tuberculosis, and pneumonia and influenza) still constitute the more important causes of death in Puerto Rico (more than 40 percent of all deaths), mortality at each age can be further reduced and the low levels already prevailing in the more advanced countries may well be reached before long. However, if fertility remains practically stationary at the present high level, the immediate result of such a reduction in mortality will be an acceleration of the rate of population growth.

From the standpoint of population distribution, Puerto Rico is still a predominantly rural area (table 3). In 1950 about 60 percent of the population lived outside of places having 2,500 or more inhabitants. In the United States in 1950 about



Most of the people in Puerto Rico still live in rural sections despite the fact that in recent years the population has been shifting rather markedly to urban centers of 2,500 or more inhabitants.

40 percent of the population lived outside of places of 2,500 or more. A rapid urbanization of the island has been going on, however, since about 85 percent of the population was rural in 1900 and 78 percent in 1920.

Table 3.—Population of Puerto Rico, by urban and rural, and percent rural: 1899 to 1950 ¹

Year	Total	Urban	Rural	Percent-age rural
1899-----	953, 243	138, 703	814, 540	85. 4
1920-----	1, 299, 809	283, 934	1, 015, 875	78. 2
1950-----	2, 210, 703	894, 813	1, 315, 890	59. 5

¹ Data from Bureau of the Census.

The prevalence of a high birth rate in the rural areas greatly intensifies Puerto Rico's problem of too many people on too little land. In an agricultural economy strongly dominated by outmoded techniques and tradition the only practical solution lies in a calculated parting with the past on many fronts.

The Course of Migration

Population increases in Puerto Rico would have been even greater were it not for the generally continuous stream of migration away from the island. The migration of Puerto Ricans started early. By the 17th century the population of Puerto Rico had been greatly reduced by the migration of settlers and natives to Peru because of

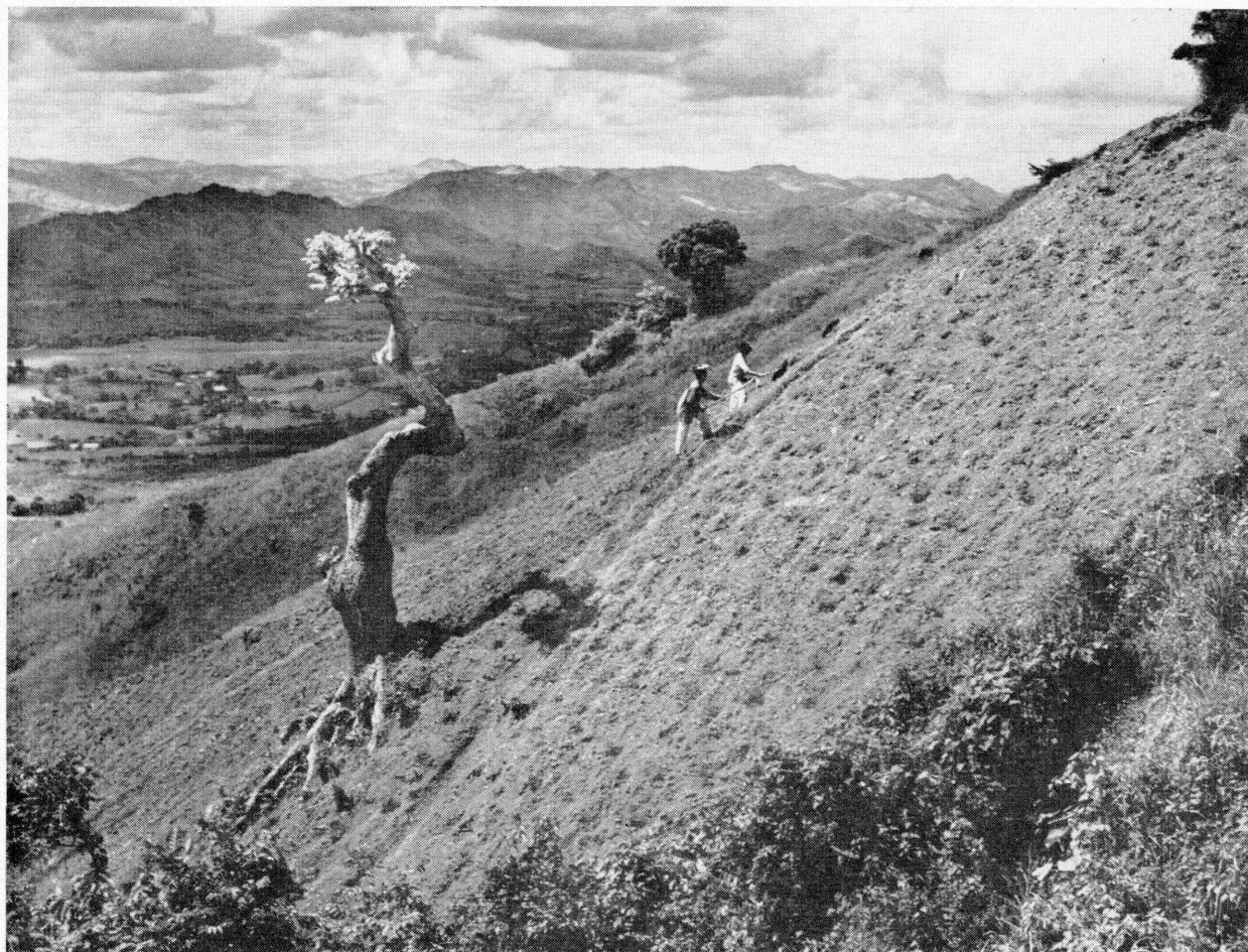
opportunities in gold mining. During the 18th and 19th centuries, however, the movement of people away from the island was very small. It increased in the 20th century and the rate has accelerated in recent years.

Within Puerto Rico itself there has been a considerable shifting of population over the years. For some time before the 20th century migration within the island tended to be from the coast toward the mountainous interior. This trend changed and in recent years the movement within Puerto Rico has been away from the rural areas and into the towns and cities of the island.

Much of the migration from the rural to the urban areas of Puerto Rico has been due to the steadily increasing pressure of population on land resources that were being drained of their productivity and wasted by neglect or unwise use. Most of the migrants came from the mountain areas whence they were forced by the competition for survival in a pattern of farming that had persisted for generations without change. While soil was being eroded and washed down the rivers, people were being washed down from the slopes to settle in urban slums.

As a result of this out-movement, the number of persons employed in agriculture in Puerto Rico has been more or less static since 1910. Since work opportunities for the increasing rural population had become limited, many of these people had to find a means of making a living elsewhere. Some moved into the surrounding towns, but a large percentage found their way into the larger cities of Puerto Rico where some industries were being established. The number of new jobs in these cities, however, was in most instances smaller than the number of migrants plus the increase in the number of wage earners within each city itself. This situation caused many migrants to find themselves in desperate circumstances and many of them settled in slum areas.

The increase of available labor in the rural sections and in the cities of Puerto Rico also had the effect of keeping wages and working conditions at very low levels. Because of this situation, the more ambitious laborers started migrating to the Dominican Republic, Hawaii, and in larger numbers to the mainland. In the last two decades, migration to the Dominican Republic and Hawaii has stopped but that to the mainland has increased considerably, especially in recent years.



The growing of clean-cultivated crops on steeply sloping lands not only requires a great deal of hand labor but it also accelerates soil erosion and depletion.

During the 30-year period from 1910 to 1940 the net movement of people away from Puerto Rico (table 4) was of modest proportions—about 58,000 individuals (net). In the following 10 years, the out-movement was considerably accelerated and nearly 190,000 persons (net) left the island. The number leaving is apparently continuing to increase rather sharply. The total for 1951 indicates a net out-movement of about 53,000, which for this year alone approximates the total for the whole 1910–1940 period. Whether the recent high rate of out-migration will continue in the years ahead and serve to ease the population pressure against the limited physical resources of Puerto Rico remains to be seen.

A large percentage of the migrants who are leaving the island are between 20 and 47 years old. The educational level of the migrant is usually

better than the average of the community that was left behind. Thus, migration is having the effect of distorting the age distribution of the population and of reducing the number of able and ambitious workers.

Table 4.—Net migration from Puerto Rico, 1910 to 1951

Calendar year:	<i>Net out-migration</i>
1910–40.....	58,000
1941.....	600
1942.....	1,700
1943.....	3,200
1944.....	11,200
1945.....	13,600
1946.....	39,900
1947.....	24,600
1948.....	32,800
1949.....	25,700
1950.....	34,700
1951.....	52,900

In addition to the migration of those who settle permanently outside the island, there has been in recent years a temporary migration of Puerto Rican laborers to the States. This movement is seasonal and takes place mainly during the summer and fall months. The migrant laborers work in the production and harvesting of fruits, vegetables, and other crops, primarily in the Eastern and North Central States.

The number of agricultural workers going to the States from Puerto Rico for seasonal employment on farms and in some food-processing plants has consistently increased in recent years, from about 2,000 in 1948 to about 12,000 in 1951. This type of temporary migration, occurring as it does during the time of the year when employment in agriculture in Puerto Rico experiences a seasonal decline, is very beneficial both to the worker and to the island's economy. At the same time, it helps meet a real need for additional labor among farmers in the States during their season of peak operating activity.

Most farmers and others in the States who have employed Puerto Ricans have found them to be good workers. One great difficulty has been the inability of a very high percentage of these workers to speak or even understand any English. Also, those who come to the States for the first time encounter difficulties in readily adapting themselves to the entirely different working and living conditions which they must face so suddenly. Of course, in time most of these people become more or less adjusted to their new environment.

But, much of the inconvenience and hardship for all concerned could be avoided if the migrants, before leaving Puerto Rico, received proper orientation that would prepare them for coming to the States with a clearer understanding of what adjustments they will have to make. Through such a program the prospective migrant would have the opportunity of learning in advance what he or she would be up against in the States, and perhaps get a chance to pick up some basic English or at least understand the meaning of a few basic English words. Such an orientation program would not only instill greater confidence in the individual, but it would also provide the person with a better basis for making a decision on whether or not to migrate.

Some orientation work with migrants is being done by the Puerto Rican Department of Labor and the United States Employment Service. This, however, is proving inadequate in view of the increased load of work and the island's need for still greater migration. The orientation activities need to be broadened and the educational work intensified so as to be more helpful to prospective migrants throughout the island. Providing an adequate and competent staff to handle such a program would be a worthwhile investment from every standpoint.

The fact that Puerto Rico is now losing through migration some of the more skilled workers on the island should focus attention on the need for vocational training to reach far greater numbers of people so that the island's needs for skilled workers may also be met. With the already great and increasing density of population in Puerto Rico, there should be no stinting on training workers, provided proper consideration is given to the employment opportunities that afterwards will be open to these people either in the States or in Puerto Rico.

While migration away from Puerto Rico is beneficial, in the ordinary course of events it will not solve the problem of the rapid growth of population. During a depression it might even boom-erang, since Puerto Ricans out of work in the States would tend to move back to Puerto Rico. Nevertheless, migration from Puerto Rico, if properly guided, can be a helpful tool in providing an outlet for some part of the increased work force which cannot be taken care of by the expansion of production on the island.

Cultural Characteristics

By far the majority of Puerto Ricans are of Spanish descent, but a sizable proportion of the population (about one-fifth) is Negro, or has some Negro blood. There is also an insignificant amount of Indian blood diluted among both white and Negro inhabitants. The early Spaniards enslaved the Indians and in a few generations absorbed the small Indian population of the island. Early in the 16th century, Negroes were imported as slaves to work in the sugarcane fields and the trade continued until early in the 19th century. Both the Indian and African cultures had some influence in the cultural patterns of Puerto Rico.

Socially, the people of Puerto Rico may be grouped into three major strata: (1) the upper, (2) the middle, and (3) the lower. The upper class in the rural areas includes large landholders and owners of estates and sugarcane mills, and the top employees of the sugar plants. In the urban areas the upper class is composed of bankers, rich merchants, some manufacturers, rich farmers living in town, and the best paid professionals. The middle class in the rural areas consists mostly of employees of sugar mills, managers or *mayordomos*, a small number of government employees living in rural communities, and medium-size farmers. In the urban areas, the middle class is larger and includes all types of white-collar employees and small business men. The lower class consists mainly of laborers in the urban areas while in the rural areas both farm laborers and very small farmers are included. A small percentage of the skilled laborers, however, is beginning to be considered as part of the middle class.

Thus, one of the most important factors in determining the social standing of a person is economic status, that is, income, occupation, size and value of landholdings, size and volume of business, etc. Caste is rather unimportant in the formation of the overall social classification. However, in the upper class, caste lines are more rigidly established. The importance of caste decreases in groups of lower income. Among the working people it is common to see marriages of white and colored persons and the sharing of social activities between them. In the last 50 years the tendency has been for caste lines to diminish in importance.

Education and Literacy

American culture has exerted quite a strong influence in Puerto Rico during the last 50 years even though Spanish traditions persist. This is significantly apparent especially in the upper and middle classes of the island's population. The average Puerto Rican is an unselfish individual with a deep sense of justice and respect for legal authority. However, many people still lack education, and this has sharply limited opportunities and retarded advancement for a vast segment of the population.

There has been a constant increase in school enrollment and literacy during the last 50 years

A continuing campaign for universal education has been waged by Puerto Rican authorities. But, the big limiting factor has been the inability of the Government to provide the teaching personnel and educational facilities required even though an exceptionally large part of the total budget is being spent for educational purposes. This is because the deficiency in education has been so great that, with a steadily increasing population, the Government simply does not have enough funds available to satisfy the need for teachers and schools and at the same time provide adequately for other essential functions and services.

Despite the many handicaps, there has been substantial progress in education in Puerto Rico. In 1900, only 8 percent of the population between the ages of 5 and 17 were enrolled in the schools of the island; in 1950, there were 52 percent enrolled (table 5). Conversely, however, the fact that 48 percent of the population of school age were not in school in 1950 points up the scope of the educational problem that still remains to be overcome.

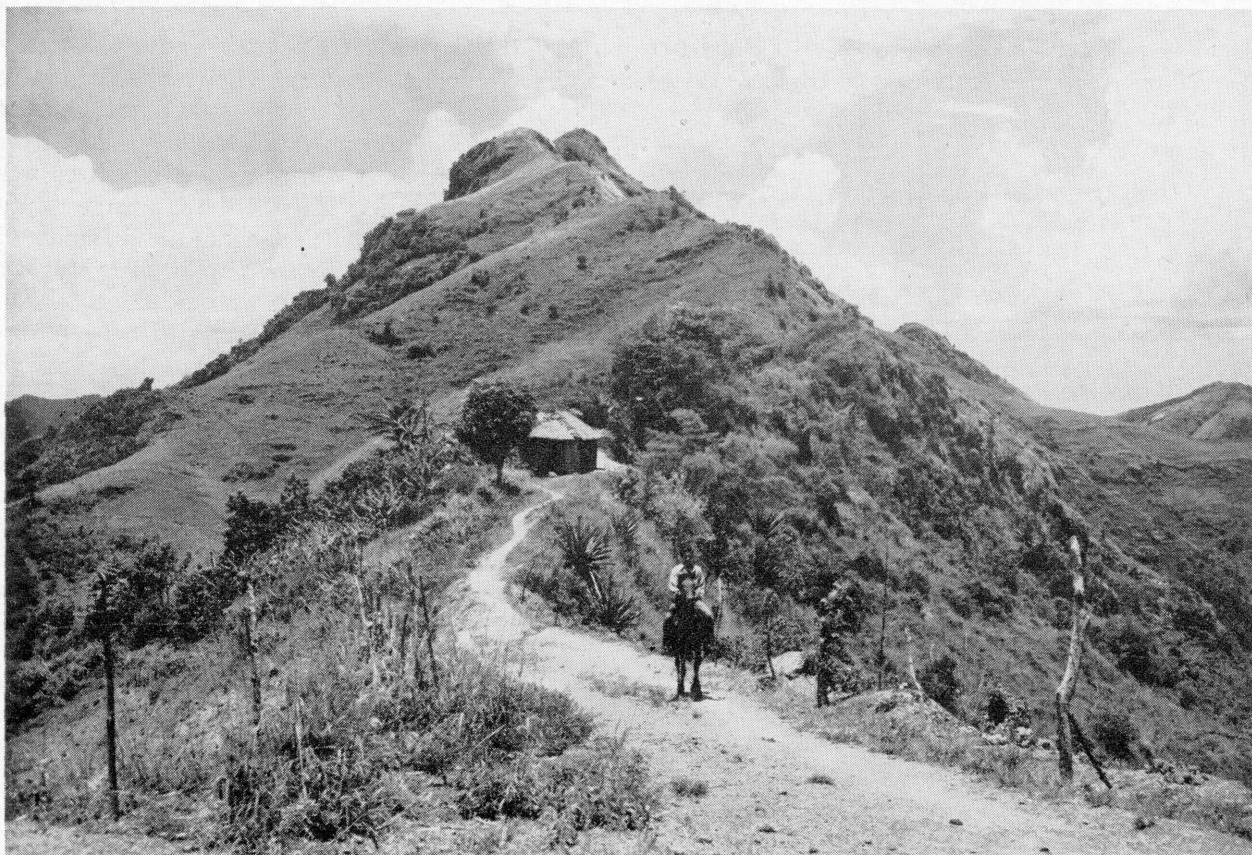
Table 5.—Percent of persons 5 to 17 years old enrolled in school, 1899 to 1950 ¹

Census year	Percent enrolled in school	Census year	Percent enrolled in school
1899-----	8.0	1930-----	39.3
1910-----	35.2	1940-----	47.7
1920-----	45.3	1950-----	52.1

¹ Data from Bureau of the Census.

Availability of school facilities is so limited that, in most areas, schools are operating on double shifts with resulting detriment to the education of the youth.

It is in the rural areas of Puerto Rico that the educational problem is most acute. Many sections have no schools available for the children to attend. In places where there are schools, a number are no more than single-room shacks with very meager equipment. And yet the rural areas have the most children of school age. The 1950 census shows that the rural areas of Puerto Rico had about 64 percent of the population between the ages of 5 and 17 which for the island as a



Although much progress is being made to improve living conditions in Puerto Rico, there still remains a great deal to be done. This is especially true in the mountainous interior, where many rural people must live handicapped by poor roads, a lack of electricity, inadequate housing, and numerous other deficiencies.

whole totaled 718,000. Of the school-age population, 53 percent in the rural areas and 39 percent in the urban areas were not enrolled in school. From the standpoint of numbers, the school-age population in the rural areas that was not enrolled in schools totaled 243,000 in 1950, or almost $2\frac{1}{2}$ times the total for urban areas.

Because of the limited opportunities for attending school, the rural areas have a lower percentage of literacy, about 70 percent of the rural people being able to read and write, against 82 percent in the urban areas. For the island as a whole, 3 out of every 4 persons 10 years old and over in 1950 were able to read and write. In 1900, only about 20 percent of the population 10 years old and over could read and write. In the United States in 1950, nearly 9 out of 10 children between ages of 5 and 17 were attending school, and less than 2 percent of the population 10 years old and over could neither read nor write. Literacy in Puerto Rico is, of course, lowest among people in

the higher age groups since they have not had the educational opportunities now available on the island. As younger Puerto Ricans supplant the older generations, the literacy of the island should tend to rise.

Spanish, of course, is the dominating language, but the use of English has been increasing. Before Puerto Rico came under the sovereignty of the United States an insignificant proportion of the population could speak English, and by 1910, only 3.6 percent of the population 10 years old and over were able to speak English. Thirty years later 27.8 percent were able to speak this language (table 6). During the last decade, however, there apparently was a decline in this proportion, since the 1950 census shows that only 26 percent of the population 10 years old and over could speak English. In the rural areas, the proportion able to speak English was extremely low, only 18 percent, compared with 37 percent in the urban areas.

Table 6.—Population of Puerto Rico 10 years old and over, by ability to speak English, 1899–1950¹

Census year	Persons 10 years old and over (number)	Able to speak English		Distribution of persons able to speak English	
		Number	Percent	Urban (percent)	Rural (percent)
1899---	659, 294	-----	-----	-----	-----
1910---	781, 600	28, 262	3. 6	-----	-----
1920---	904, 423	89, 427	9. 9	-----	-----
1930---	1, 093, 423	212, 231	19. 4	-----	-----
1940---	1, 337, 163	371, 132	27. 8	42. 2	20. 8
1950---	1, 526, 154	398, 293	26. 1	36. 5	18. 3

¹ Data from Bureau of the Census.

The census classification as to ability to speak English is based on the replies to the question "Does this person know how to speak English?" Since no specific test is required, affirmative answers were doubtless reported for persons who can speak English only slightly. Although some bias is present—probably a differential bias from census to census as knowledge of English becomes a prestige factor—there nevertheless has been an increase from decade to decade in the overall proportion of the Puerto Rican population reported able to speak this language. However, the slippage that took place in the last decade should be cause for concern among the Puerto Ricans themselves in view of the great need for broadening the field of opportunity for a steadily increasing population. Experience in Puerto Rico has demonstrated that persons able to speak English are thus equipped with an additional and important key to improved employment opportunities on the island and especially in the States.

Although Spanish has always been the language of instruction in the elementary schools (grades 1 through 6), English, which had hitherto been the language of instruction in the intermediate and high schools, was supplanted by Spanish late in the 1940–50 decade. The schools now have specific periods for teaching English just as they do for any of the other classroom subjects. Thus, the present policy is to use Spanish as the working language and teach English as a second language beginning in the elementary schools.

Without question the reversion to Spanish as the language of instruction has simplified the problem

of education in Puerto Rico, both for the pupils and the school authorities. Spanish is the native tongue and for people who speak nothing but Spanish it is extremely difficult to change over suddenly to a complete usage of English as was necessary when English was the language of instruction in the schools. Besides the difficulty of learning experienced by the pupils, there was the difficulty of the instructors who did the teaching. Practically all teachers in Puerto Rico are native to the island and they do not have the command of English required for adequate instruction in that language. Even in the teaching of English alone, most of the teachers are tremendously handicapped because of inadequate training in the language and a heavy Spanish accent. Also, it is very difficult to attract to Puerto Rico any number of teachers from the States, largely because of the very low salaries paid.

Nevertheless, as the population of Puerto Rico expands, it becomes more and more important for the people of the island that an increasing proportion of them be able to speak English. Puerto Rico is a part of the United States, and the people of this island as American citizens have a right to opportunities available to every other citizen. Just as a saw is used by a carpenter in his work, so English is one of the necessary tools universally employed in the States. And unless one has the ability to speak English, opportunities in the States are definitely limited, since it is the common working language, just as Spanish is in Puerto Rico. Also, English has grown in importance as an international language. Thus, from many standpoints, the people of Puerto Rico have much to gain from a more widespread knowledge of English.

The easiest time to learn any language is during the early years of life. With many Puerto Ricans leaving school even before completing the elementary grades, it is important that more emphasis on English be given from the very start of attendance in school.

The Labor Structure

More opportunities for more people is a prime need in Puerto Rico. Underemployment and unemployment weigh heavily on the economy of the island. Even though in recent years a great deal of economic expansion has taken place, the popu-

lation has also increased at a fast rate. The total number of persons gainfully employed in Puerto Rico has a little more than doubled in the past half century, rising from 316,000 in 1899 to about 662,000 in 1950-51. During the same time, however, the population total made a proportionately greater increase, climbing from a little over 953,000 to over 2,200,000 people.

With a labor force totaling 783,000 in 1950-51, only 84.5 percent of these workers were, on the average, gainfully employed during that year. The remaining 15.5 percent, or an average of 121,000 out of the total labor force, were unemployed on the island. This is quite a high proportion of unemployment, especially since 1950-51 was a relatively prosperous year. The fact is that unemployment in Puerto Rico is chronic and swings rather widely from one time of the year to another. The degree of instability in gainful employment is indicated by the fact that during 1950-51 unemployment fluctuated from a low of 12 percent in May to a high of over 20 percent in January.

The pattern in which the labor force is distributed among the various economic sectors (table 7) shows that agriculture is still the main single source of employment on the island, although the number of people working in agriculture has leveled off and there is a general tendency for the number to decline.

Manufacturing has more or less maintained its relative position, it employs around 18 percent of the gainfully employed, and in recent years the trend has been upward as a result of industrial

expansion on the island. Commerce is also an important segment, employing nearly 16 percent of the total number of persons gainfully employed. Personal, professional, and business services employ about 15 percent of the total work force.

Unemployment and underemployment are more extensive in agriculture than in any other economic activity in Puerto Rico. Recent statistics indicate that, in general, only two-thirds of the employed persons in agriculture work 30 hours or more per week, compared with three-fourths of the employed workers in nonagricultural industries.

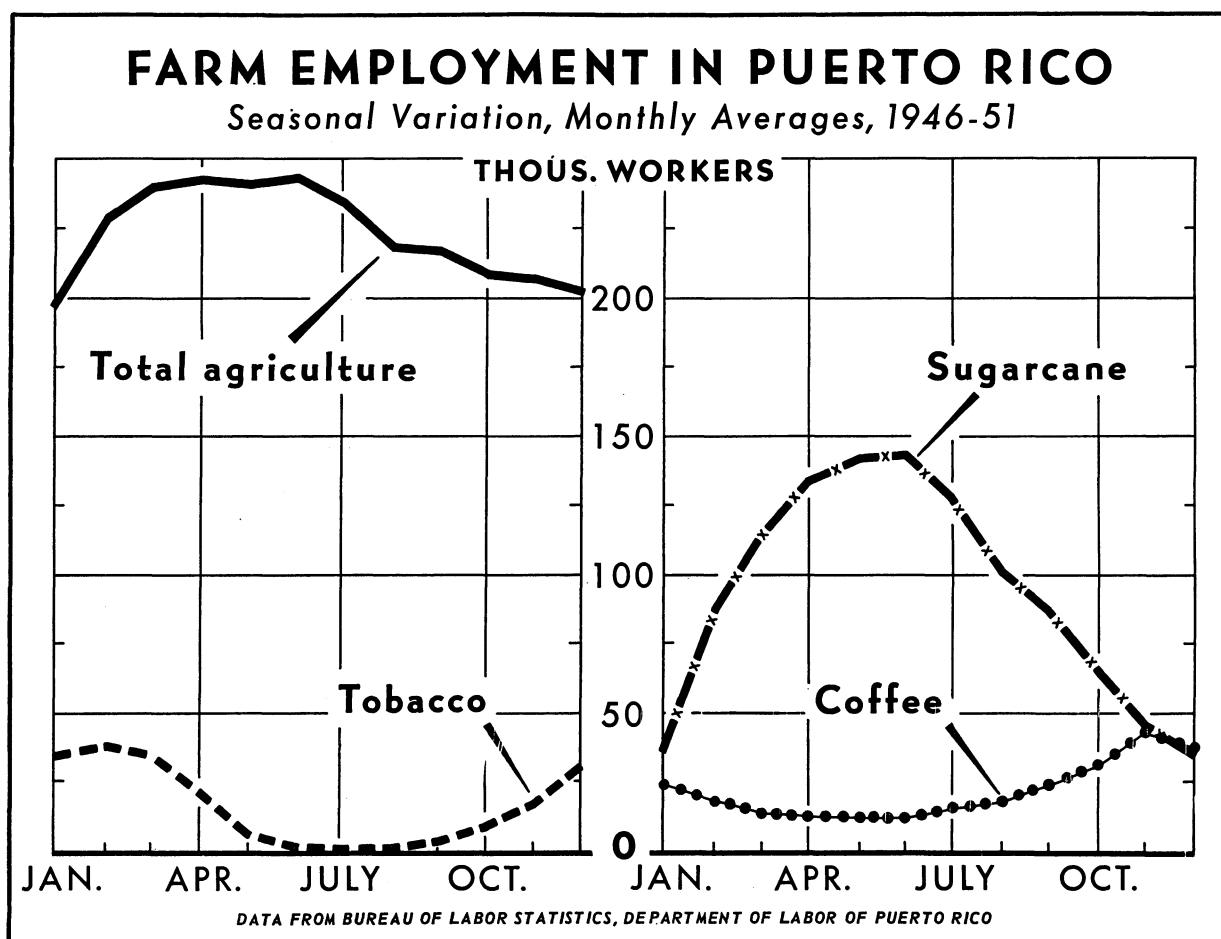
So far, the work opportunities in agriculture have been rather static. This accounts for the fact that although the population of Puerto Rico has doubled since 1910, the number of persons employed in agriculture has remained at a relatively constant level. The percentage of the total labor force employed in agriculture during this period has been reduced considerably, from slightly over 60 percent in 1910 to only 34 percent in 1951.

Agricultural employment is highly seasonal and varies from a peak of around 240,000 from March to June, to a low of around 200,000 in December and January. From July to January, there is a considerable drop in agricultural employment, mainly because of the seasonal work slack in the sugarcane fields.

During the 1946-51 period the fluctuations in employment in sugarcane increased considerably from one time of the year to another. For example, the number of persons employed on sugarcane farms in 1946 fluctuated from 55,000 to 129,000.

Table 7.—Distribution of total labor force for Puerto Rico, 1950-51

Economic activity	Persons gainfully employed	Percentage of total gainfully employed	Persons unemployed	Percentage of total unemployed	Total labor force	Percentage of total labor force
	<i>Thousands</i>		<i>Thousands</i>		<i>Thousands</i>	
Agriculture-forestry and fishing.....	224	33.8	37	30.6	261	33.3
Manufacturing and handicraft.....	121	18.3	30	24.8	151	19.3
Construction.....	30	4.3	13	10.7	43	5.5
Mining.....	1	.2			1	.1
Commerce.....	103	15.5	10	8.3	113	14.4
Transportation and communications.....	30	4.5	5	4.1	35	4.5
Services.....	97	14.7	13	10.7	110	14.0
Government.....	56	8.5	4	3.3	60	7.7
Unclassified.....			9	7.4	9	1.1
Total.....	662	100	121	100	783	100



While agriculture ranks first as a single source of employment in Puerto Rico, the amount of work available on farms varies widely from one time of the year to another. The peak of total farm employment occurs during the spring months when the harvesting of sugarcane is at its height.

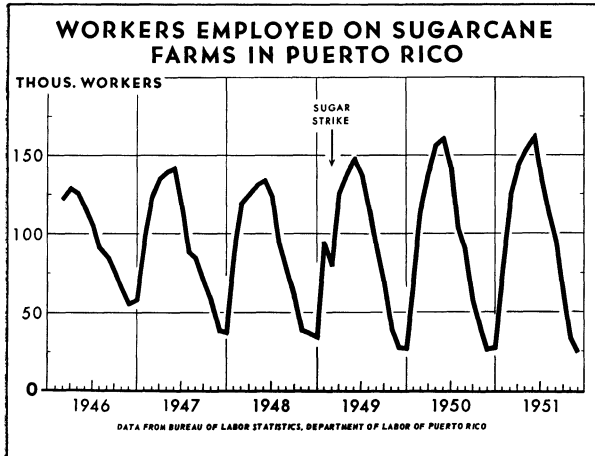
This seasonal swing has become more abrupt each year. In 1950, for instance, the employment on sugarcane farms fluctuated from a low of 26,000 in December to a high of 161,000 in June.

The biggest need for labor on sugarcane farms is during the cane cutting season which mostly starts around January and continues into July. The peak of the harvest season is during the months of March, April, and May. Although growers prefer to cut their cane during these months when sucrose contents are highest, cutting has to be spread out over the January-July period. This provides for orderly delivery to the *centrals* where the cane is ground, and helps insure efficient processing operations by these mills.

Although rising numbers of workers have been employed in recent years to harvest the cane, the trend in the number of workers required has not been the same for cane production, despite the

sharp increase in cane acreage over the last few years. This is due mainly to changes that have taken place in the growing of cane. Although the entire sugarcane crop of Puerto Rico is cut manually and requires large numbers of workers, there has been some reduction in the amount of labor needed for growing the cane. Tractors and other mechanized equipment are being used more extensively. Also, many farms have adopted the use of chemical weed killers, and thus have reduced the necessity for so much hand hoeing and weeding. The various changes, however, are strongly resisted by the workers even though the improved techniques result in higher efficiency and increased productivity with potentially greater benefits for the island's economy as a whole.

An individual employer in Puerto Rico, especially a grower of sugarcane, is apt to employ a large number of agricultural workers. This has



The seasonal fluctuation in employment on Puerto Rican sugarcane farms has widened in recent years. Although the acreage of sugarcane was increased, the number of workers required to grow the crop has been decreasing as the result of improvements in production techniques. More workers have been required during the harvesting season, however, since on the island sugarcane is still cut by hand.

been conducive to the organization of labor unions. These unions have been a factor in raising the wage level for sugarcane workers and they have been able to bring about some improvements in working conditions through collective bargaining. In general, however, the most important changes in wages and working conditions have come about through legislation, both Puerto Rican and Federal, and the decrees of wage and labor relations regulatory bodies. Of course, some of the legislation affecting labor has been influenced by the labor organizations.

Agricultural labor unions in Puerto Rico are loosely organized and there is a large turnover in dues-paying members. No single labor organization holds a dominant position since there exists a relatively large number of so-called syndicates and independent unions. In the last few years the strongest labor organization in agriculture has divided itself into several groups, mostly as a result of personal differences among leaders. The existence of so many different labor groups greatly intensifies competition for membership support and opens the way for these groups to out-bid each other in their demands without regard for other considerations affecting the welfare either of workers or of the economy. Such a situation is made to order for irresponsible leadership. Although the agricultural labor movement in Puerto Rico was begun and reached an organized state much earlier than on the mainland and is more

of a factor than in the States, there still is a great need for developing among workers and their leaders a basic understanding of the fundamental economic and social problems of the island and labor's relation to them.

To a considerable extent labor productivity in Puerto Rico is governed by attitude. Through systematic education laborers and labor leaders should be able to bring about a change in attitude and broaden their outlook, thus increasing labor's effectiveness and productivity for the benefit of workers and the economy as a whole. Of course, employers also need education. As yet, however, the surface has hardly been scratched in this important field of labor and employer education in Puerto Rico.

The Picture on Income

The extent to which people are employed and their productiveness as workers are, of course, reflected in the general level of income. In Puerto Rico the income level is low. Although per capita net income has been increasing steadily since 1939, by 1946 it was only \$271, compared with \$1,211 for the United States and \$587 for Mississippi, the State with the lowest income. The 1950 census shows that in Puerto Rico 43.4 percent of all persons 14 years old and over with any income whatever had made less than \$300 in 1949, compared with only 3.2 percent who had incomes of \$3,000 or more.

The general level of income among those earning money is much higher in urban areas than in the rural sections of the island. The median income of all persons 14 years old and over who earned any money during 1949 was \$378. In the urban areas the median was \$617, but only \$275 in the rural areas. About half of the total population 14 years old and over earned no income, with 57 percent of this segment in the rural areas.

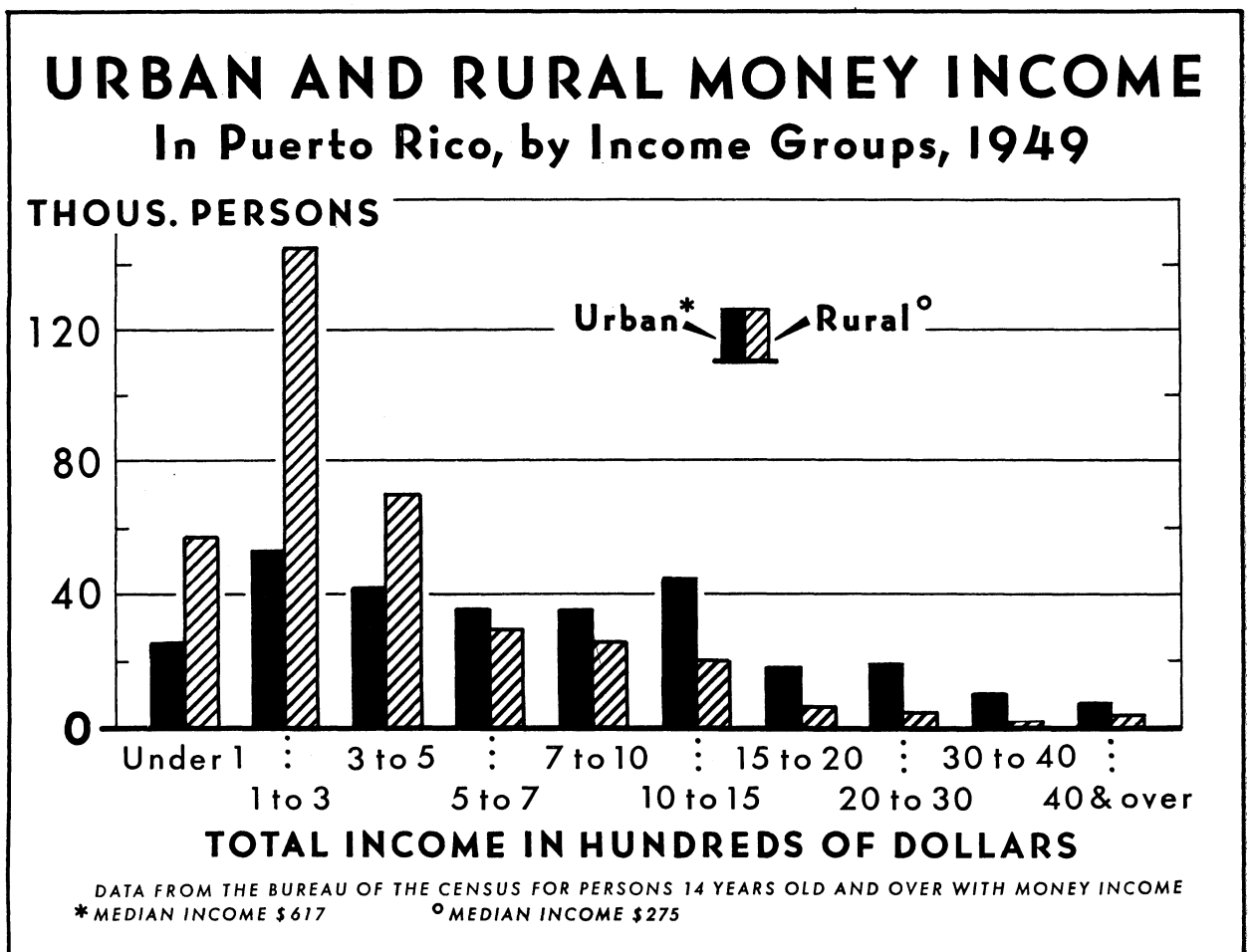
Among those having a money income, the distribution is better in the urban areas than in the rural parts of the island. Only 29.6 percent of the urban people with any income whatever in 1949 earned less than \$300, as compared with 54.9 percent for those in rural sections. An additional 14.2 percent in the urban areas and 19.3 percent in the rural areas earned between \$300 and less than \$500. Thus, about 44 percent of the urban people with income and 74 percent of those in rural areas earned less than \$500 in 1949. The

higher income bracket ranging between earnings of \$500 and under \$1,500 covered 38.1 percent of the urban people with income and only 21.3 percent of those in rural areas. In the group of people who earned \$1,500 and over, the urban areas had about 3½ for every such earner in the rural sections.

The pattern of very low and poorly distributed income hangs like a pall over the rural areas of Puerto Rico. The income statistics become mere symbols of the widespread privation and suffering existing among the many country people who lack enough buying power for basic necessities. The imprint of unemployment and underemployment in the island's agriculture stands out in bold relief when viewed against the potentialities that could be realized through the adoption of improved methods, greater diversification, and the

exercise of more initiative and resourcefulness in the use of both human and natural resources.

The generally low level of productivity that results from the present use of labor and land resources makes it virtually impossible for many thousands of workers to earn anything like a decent living. The highest paid laborers in the agricultural field are the sugarcane workers (around \$2.90 to \$3.40 per day in 1951-52) but they are employed on the average only less than half of the year. With large families to support, it is obvious that this low income earned during the relatively short work period does not permit the sugarcane worker to save anything for the time when he has no employment. As a matter of fact, during the dead season (*tiempo muerto*) many sugarcane workers and their families often end the day hungry. Those workers who own small tracts of land



Although the general level of income is low in Puerto Rico, the amount of money received per capita is much lower in rural than in urban areas. The distribution of income also is much better in the urban centers than in the rural sections.

(usually less than 3 acres) receive a small income from their lands, besides what they make in wages, but this does not average more than \$40 or \$50 per year.

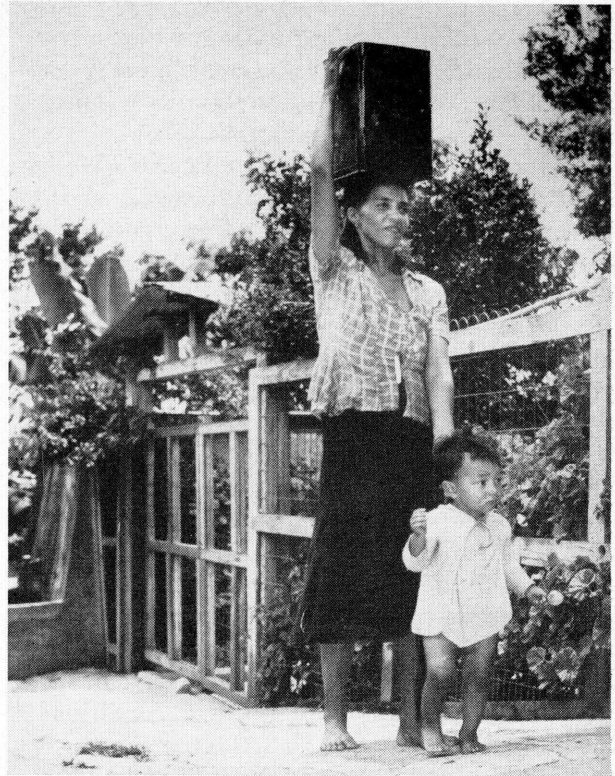
The lot of workers employed in tobacco, coffee, and other agricultural enterprises is even worse. Most of the farmers who produce these other crops are small operators and very few of them have broken away from traditional production and marketing methods. Since the income of these farmers is generally low, the wage paid to labor is also low. In fact, it is much lower than in sugarcane. Even though these other crops provide work for a greater number of days during the year, the annual cash income of the worker is usually still lower than that of the sugarcane laborer.

Rural Living Conditions

During the last few years there has been a significant improvement in housing in Puerto Rico. The rural sections, however, have lagged considerably behind the urban areas in this advance. For the island as a whole, there was an addition of 92,000 dwelling units during the decade since 1940. Although the population increased by 18 percent, the number of dwelling units increased by 25 percent. Most of the gain in housing was through new construction, and building activity is still continuing at a lively pace under both public and private sponsorship.

One striking development is the fact that thousands of families who had lived under pitiful conditions in urban slums now occupy decent living quarters for the first time in their lives. Also, in the rural areas, thousands of landless squatters and farm laborers living in makeshift shacks have been resettled in rural communities organized to accommodate from 100 to 500 families. Each family is provided with a plot of land on which to build a simple, low-cost house and also produce some subsistence crops.

But far more remains to be done to improve living conditions in both urban and rural sections. In 1950, about 26 percent of the urban dwelling units and 37 percent of the rural ones were dilapidated. Of those reported as not dilapidated, 94 percent of all rural and 60 percent of all urban dwelling units were not equipped with private bath and flush toilet facilities. Moreover, 84 percent of the rural homes had no inside running water, compared with 42 percent in urban areas.



No running water in her house, so she carries it from the nearest source of supply.

Since Puerto Rico is subject to hurricanes, structures must be able to resist the force of terrific winds. A large number of the houses on the island will not stand up in a severe hurricane. More than three-fourths of the dwelling units both in urban and rural areas are still built of wood, although this is a decrease from 1940, when about 90 percent were made from this material.

Most inadequate, however, are the houses made of straw, palm wood, galvanized iron and wood, or similar materials. These offer little protection from either rain or wind. And yet, many dwellings on the island are of such poor construction and most of them are in the rural areas. These flimsy houses are occupied by very low-income families. For example, in the rural areas, they provide a "home" for over 40 percent of the families earning less than \$500 a year. Of course, this percentage drops very quickly as income increases.

Only 5 percent of the rural houses are made of concrete, compared with about 22 percent in the urban areas. The use of concrete has increased in the last decade with the development of a rather substantial cement industry on the island. About

13 percent of all dwelling units are now of concrete, compared with only 6 percent in 1940. Cost of concrete construction, however, is a limiting factor for most of the population.

The average dwelling unit in Puerto Rico has about 3 rooms. Over-crowding prevails in most homes, since the average family, especially in the rural areas, is large. Over 70 percent of the rural people live in houses of 3 rooms or less and, for the most part, occupancy of these dwellings is by families with incomes of less than \$500 per year. This compares with 44 percent in the urban areas.

Since most of the homes are small and families are big, the number of persons sleeping in a single room is large. In fact, in about three-fourths of the rural families there are three or more persons to one sleeping room and close to two-fifths of the population sleep in rooms with four or more persons. In the low-income bracket almost one-half of the rural families sleep with five or more persons per room. This crowded condition is made worse by the fact that the rooms are very small. In many places hammocks and cots are used instead of beds. More than three-fourths of the rural people live in meagerly equipped dwellings of 360 square feet or less.

The extension of electric service to rural areas has lagged far behind. Only about 14 percent of the rural homes have electricity available, compared with 70 percent in the urban areas.

Also sorely lacking in the rural areas are adequate means of communication. Telephone service is unavailable in most sections and when a call has to be placed it is made in the nearest town, usually at the telephone company's local headquarters. The equipment operated by the telephone system is antiquated and highly inefficient. Service is poor at its best.

Mail service is far short of requirements. Only a very few rural free delivery mail routes have been established. Rural dwellers distant from town have to get their mail direct from the post office, or else have it addressed in care of their local country store to be picked up by the storekeeper when he goes to the post office for his mail. Often, where mail service is unavailable, bus drivers are used to carry messages for those who want to communicate with others in communities along their route. The bus drivers also

bring newspapers to rural communities and deliver various packages and supplies.

Two newspapers have island-wide circulation, but most of this is in the metropolitan areas of San Juan and in other cities and towns. Many of the people in the rural areas rely heavily on the radio for their news, information, and entertainment. However, relatively few rural families have radios. The island has a large number of radio stations, but most of the competition is in broadcasting advertising rather than in providing programs that will meet the needs of listeners.

In regard to water facilities, more than half of the Puerto Rican families obtain water from an aqueduct, about one-fifth from springs, deep wells, and rain, and nearly one-fourth from rivers, surface wells, and other sources open to contamination. The source differs markedly in rural and urban districts. In the urban zone over 97 percent of all families have access to an aqueduct supply, and only the small remainder get it from other sources. In contrast, less than one-fifth of rural families obtain water from an aqueduct and a little over one-third from springs, deep wells and rain, while over 40 percent drink water from streams, ditches, and surface wells.

How much of the water used in rural areas is safe or unsafe to drink is problematical. The water from the aqueduct is supposed to be safe, also that of springs and rain if properly stored. But the water from the streams, ditches and canals, or surface wells is definitely unsafe, since all of these sources are exposed to pollution. Such water may be a carrier of any number of waterborne disease organisms and thus be a constant menace to the health of those who drink it.

Many diseases common in Puerto Rico may be transmitted through human excreta. Chief among these are the diarrheas and dysenteries, uncinariasis or hookworm, and other bacterial and parasitic diseases which are responsible for much of the illness and physical impairment of the people. Sanitary disposal of human waste is thus almost a first essential of health. In the rural zone only about 5 percent of the families have a flush toilet. More than one-fourth of the rural families lack any kind of toilet facilities. They use the yard, field, beach, or streams. That is why most of the rivers are contaminated.

It is estimated that in the rural sections over two-thirds of the families have unsanitary latrines



Water running in Puerto Rico's rivers and streams is used for many household purposes despite pollution and other dangers. The people who do so usually do not have access to an alternate water supply that is safe.

or none at all. This means that much of the land area of rural districts and the water that drains from this land are polluted from human excreta. This situation constitutes a grave menace to the health of the island. Infection with disease organisms is easily spread through drinking water, through food coming in contact with the soil or, as in the case of hookworm, through direct exposure of the feet or other bodily part to the polluted soil.

Rural families enjoy few amenities. They are very seldom able to go to a movie in town and there are practically no social organizations among them. There exist a few religious societies, Catholic and Protestant. The main social events are the *fiestas* during Christmas time which extend from Christmas Eve to the middle of January, and the trip to the nearby town to see the Good

Friday procession. Once in a while dances are held at country houses.

There are very few community-interest organizations, although during recent years a number of consumers' cooperatives have been organized in about 50 rural communities. Cooperatives present very good opportunities for improving the way of rural living in Puerto Rico and their organization should be fostered even more intensively than it has been so far.

All in all, conditions under which most rural inhabitants of Puerto Rico live are most unsatisfactory. The situation is, of course, made worse by the large size of the average rural family and the high percentage of the population representing children of nonworking age. Since most of the rural breadwinners make barely enough to take care of the many mouths they must feed, the

families have to depend almost exclusively on Government help in obtaining medical attention, hospitalization, and other essential services. Meeting these vital needs imposes a heavy burden on the Government of Puerto Rico. Expenditure of a large part of the budget is required to provide free medical care and hospitalization, build rural aqueducts, and supply other necessary services free to the many who cannot afford to pay. The Government, however, just does not now have all the money that should be spent for these purposes in order to meet the bare minimum needs of the population. And this again goes back to the low level of income that prevails among the people.

Level of Nutrition

A large proportion of the population of Puerto Rico is poorly nourished. Only a relatively small number of the families enjoy a diet entirely adequate in the protective foods. Approximately three-fourths of the families subsist on diets that are inadequate in dietary essentials.

The typical diet of most families consists largely of rice, beans, and *viandas* (starchy vegetables) to which are added small amounts of codfish and certain flavoring foods when money is available to purchase them. The diets in general are notably short, as compared with present diet recommendations, in good quality protein, calcium, riboflavin, and vitamin A, and probably have less than desirable amounts of many other nutritional elements.

In recent years the nutrition problem has been tackled in part, at least, through various child-feeding programs such as school lunches, milk stations, and others. These are supported by Federal and Puerto Rican funds. During 1950-51 an average of nearly 224,000 youngsters benefited from the operation of these feeding programs. The biggest contribution to improve nutrition is being made by the school lunch program with financial assistance provided under the National School Lunch Act, which is administered by the United States Department of Agriculture. An average of nearly 193,000 school children participated in this program during 1950-51. An additional 30,400 children were served at milk stations. The Federal contribution to the operation of the child-feeding programs was slightly over 3 million dollars, in terms of cash and donated foods, and

this amount was more than matched by funds from the Puerto Rican Government.

The child-feeding programs are playing an important role in the physical and mental development of growing children in Puerto Rico. Many of the youngsters are able to get their only glass of milk through the milk stations, or their only balanced meal through the school lunches. The effect of these feeding activities becomes readily apparent in a comparison between those children who have these programs available to them and those who do not. Where the feeding programs are in effect, the youngsters are much healthier, show greater gains in weight, and are more alert in their studies.

The unfortunate part is that the feeding programs do not reach more children throughout the island, especially in the rural areas. This would be possible if the same formula for allocating funds to the States under the National School Lunch Act were used in calculating Puerto Rico's share. Instead, a formula is now employed which limits the funds allocated to Puerto Rico considerably below what they otherwise would total. Congress would have to amend the act to afford the children in Puerto Rico the same opportunity that the children in the States have to participate in the school lunch program. Such an amendment would help the children of Puerto Rico grow into healthy, useful citizens who will be able to make their full contribution to the welfare of the island and the United States.

The lowest dietary levels prevail in the rural areas of Puerto Rico where there are the most people with low incomes. Compared with the situation in the urban areas, only a negligible segment of the rural population actually has an adequate diet.

In the last 10 years there has been a substantial increase in the amount of milk consumed on the island. A sizable part of this increase has been brought about by the serving of milk at the feeding centers. Improved economic conditions over the years and the continuous educational campaigns have also contributed to this increase in consumption. At present, however, the amount of milk and milk products available per capita on the island totals much less than 10 ounces per day.

The lowest consumption of milk is in the rural areas, where many families have no milk available to them. A large proportion of the milk used on



The school lunch program makes a valuable contribution to the diets of many children in Puerto Rico.

the island is imported from the States in the form of dried or canned milk, and practically all of the butter and most of the cheese comes from outside. The use of dried skim milk has increased in recent years, and a rather large volume of this product is used both for the child-feeding programs and for commercial sales in small packages for home use.

Egg consumption in Puerto Rico, as in the States, is largely determined by the income of families. Over 30 percent of those Puerto Rican families with an income of \$500 or less use no eggs at all. The annual consumption of eggs in rural areas probably averages 65 per capita, compared with less than 100 per capita in urban sections. For the island as a whole, egg consumption per person is only about a fifth of what it is on the mainland. In order to get money to buy a more filling food, such as rice, which will for the

money provide a far greater number of calories, the families in the rural areas with very low incomes frequently sell, rather than consume, the few eggs they may produce.

The most commonly used protein food is imported dried codfish. This is used mostly by the middle-income people. The lower-income families must limit their consumption of codfish because its price has so increased as to make this food almost prohibitive for them. The more well-to-do consume only small amounts because they can afford the more expensive proteins, such as meat, eggs, and milk.

Meat is consumed only when it can be afforded and, therefore, its use is largely limited to the higher-income groups. One-third of the Puerto Rican families rarely have any meat. Fowl is considered a luxury food, yet it is consumed more by the rural families than by the urban since rural dwellers have more of an opportunity to keep a few chickens around, although in the last few years there has been quite an increase in commercial broiler production to supply urban areas.

Starchy vegetables (*viandas*) constitute the bulk of the food of low-income families. As these starchy vegetables are eaten in large amounts, they supply not only daily calories but also other nutrients. Recently some efforts have been made through educational campaigns and other means to stimulate the preference for the yellow varieties, especially in the case of pumpkins or squash and sweetpotatoes. These varieties produced in Puerto Rico are very rich in carotene and provide a fine source of vitamin A for the local diet.

Green and leafy vegetables, however, are utilized only by a very small percentage of the population in both urban and rural areas, even though there has been an increase in recent years.

The consumption of fruits on the island has been rather low although it has been improved through educational efforts of such agencies as the Extension Service. Among the people with higher incomes there has been some tendency to substitute the more costly imported fruits having a lower nutritive value for the inexpensive and more nutritious fruits produced locally. Much could be accomplished toward improving nutrition if consumption of native fruits could be increased further.

Rice and beans have long been the principal food items in the majority of Puerto Rican homes.

Somewhat less rice is used in the rural areas than in the urban, the average weekly consumption per person being about 44 ounces in the rural areas and 47 ounces in the urban. Puerto Rican families prefer to use polished white rice which, from the point of view of nutritionists, lacks elements essential to the local diet. In view of this preference, the Puerto Rican Legislature in 1950 enacted a law requiring that all rice sold on the island must be enriched so as to add nutritional values which otherwise would be deficient in polished rice. The combination of rice and beans is a popular dish. Many Puerto Rican families prefer to use the red kidney beans, which are mainly imported. But these are not as nutritious as the locally produced *gandules* (pigeonpeas) or the imported chick-peas, both of which are used by about two-thirds of the families.

The overall food supply situation in Puerto Rico is not good and for many people this presents a serious problem. Food production on the island has not kept pace with the rapidly increasing population with the result that more and more reliance has had to be placed on imported foods. The annual value of food imports now exceeds 100 million dollars. The heavy dependence on food imports imposes a great burden on the economy of the island and also increases the cost of food to the consumer. The combination of factors affecting the food supply and its cost automati-

cally restricts the amount and kinds of food consumed by most of the population, especially the people with low incomes.

Puerto Rico can and should produce more of its own food. The island has the necessary resources for stepping up food production considerably without hampering any other agricultural enterprise. An expansion in local food production on farms and in gardens would not only be profitable and add to income as well as employment, but it would also help bring about a material improvement in the nutrition of the people.

Unless the people of Puerto Rico move forward vigorously on a program to increase food production both for home use and local sale, they must be prepared to face even more deprivation than now exists. With population increasing at a rate much greater than the rise in income from exports, the difficulty of paying for more imported food becomes obvious. An alternative fully within the control of the people of Puerto Rico is to produce more food on the island and thus help themselves to better living.

The Score at Present

The biggest resource that Puerto Rico has is the human resource. But this prime asset has been utilized most poorly of all. The people have not been employed anywhere near their productive capabilities. They have lacked the opportunities which greater initiative, enterprise, drive, and more effective organization could provide.

The many shortcomings that have prevailed still are most acute in the rural areas where the pressure of a rapidly increasing population against limited natural resources exerts its greatest impact. While the rural sections have not been neglected in efforts to bring about improvements, conditions in the urban areas are more tolerable. Private enterprise has helped in the earnest, but still inadequate, Government action to encourage industry, increase incomes, improve housing, and expand facilities and services for education, health, and other social needs. To the extent that the Puerto Rican Government has been able to follow through with its program, the measures employed have had a great influence on the pattern of living of people in the towns and cities. This is reflected not only in the well-being of these urban dwellers but also in the fact that there is a more enlightened attitude toward family responsibilities and the



On many farms in Puerto Rico it is customary to supplement the wages of workers with produce from the farm and in this way add to the diets of the laborers and their families.

birth rate is lower than the very high rate in the rural sections.

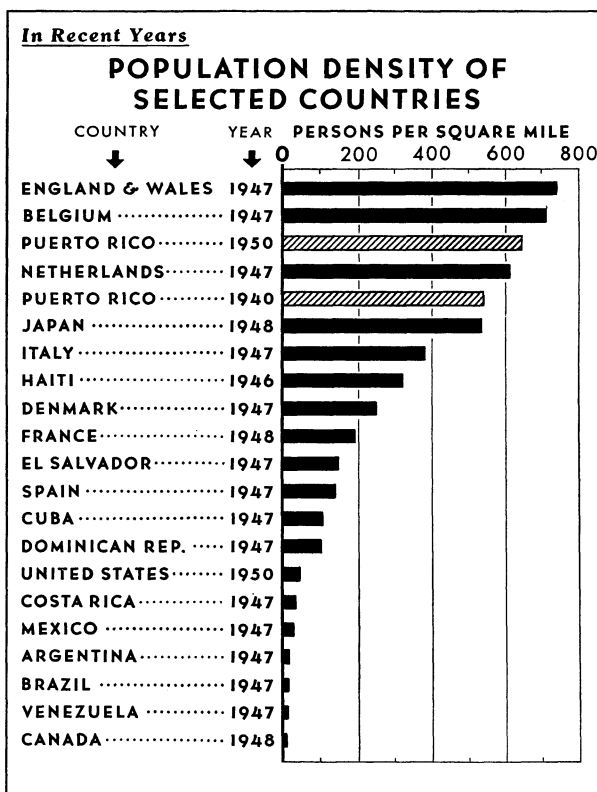
The present situation of the people of Puerto Rico is a measure of the adjustments still needed to achieve the goal of a decent standard of living. It is an open challenge to everyone who has a stake in Puerto Rico's future. The task is a formidable one. However, the extent to which improvement is attained depends largely on how great the desire for an adequate standard of living really is among the people.

There certainly is no room for complacency in the condition that still prevails for a great part of the population, even with the advances brought about on the island in recent years. And, yet, there is a complacent attitude among far too many Puerto Ricans who, in one manner or another, have adjusted their living so as to make the best out of a bad situation. This is nothing new, since for generations the people of the island have had to accommodate themselves to economic and social forces which they did not know how to control. But this accommodation is no longer necessary, as the gains already made in Puerto Rico demonstrate. The hope for the future lies in this fact.

To accomplish anything near the goal of a decent standard of living calls for full mobilization of human energies in an attack centered on fundamental problems. While the Government has a big role to play in laying out the groundwork for action, the people have an even greater contribution to make by what they do to help themselves. The latent resourcefulness of each person must be turned into an effectively functioning resource that will add to the total effort.

There is no doubt that the condition of the island is dependent on its rate of population growth. No matter what progress is made in the further development of agriculture and no matter what level of industrialization is achieved, the efforts will be more or less neutralized by a continuing rapid growth of population. This is clearly indicated by what actually has been happening. Under these circumstances, it seems reasonable to regard Puerto Rico's economic future as being dependent on the rapidity with which population growth is stabilized.

There is reason to hope that with a rising standard of living, increasing urbanization and indus-



Puerto Rico ranks as one of the most densely populated areas of the world. Between 1940 and 1950 alone the population density of the island rose from 546 persons per square mile to 646, an increase of 100 persons per square mile in a period of only 10 years.

trialization, greater literacy and a higher level of educational attainment on the island, a set of values will be adopted which will place increased emphasis on the well-being of the individual rather than on high fertility and large families. Efforts to date to impart family limitation practices have not been too effective, probably because these efforts have been expended before cultural attitudes and values, which would encourage their acceptance, have been adopted. Also, the church has stood opposed to the general dissemination of information on birth control. Nevertheless, the practice of birth control and family planning has been gradually creeping into the consciousness of the population, especially among the higher income and educated groups who are able to obtain help privately. Public assistance is available in maternal and child-welfare clinics where sterilization and birth-control measures may legally be employed in extreme cases dealing with the life

and health of the mother. This governmental service, however, has not received all the financial support and backing it actually needs to cope with the problem among the people who really should be helped.

If the human resource of Puerto Rico is to be employed more nearly in keeping with its productive capabilities, then it is essential to attack the problem where it is most acute. And that is in the rural areas of the island where the general level of income and conditions of living are deplorably low, where essential facilities for education and other social needs are sorely lacking,

and where the birth rate is among the highest in the world.

The time has come when far greater weight and consideration must be given to the serious handicaps under which the people in the rural sections of Puerto Rico must live. For the good of all, the wide gap in economic and social well-being that now exists between the rural and urban areas of the island must be narrowed, not by doing less in the towns and cities but by doing more of consequence for and in the country places where the so-called population problem has its deepest root.

Chapter III

This is the Land

When the Spaniards first came to Puerto Rico in their search for gold at the beginning of the 16th century, they found on the island a small Indian population. These Indians lived from farming, hunting, and fishing. They grew only a few crops, such as cotton, cassava, and tobacco, and had no domestic animals. The soil was very fertile and the land abounded with trees and wildlife.

For about two decades after the colonization, the Spaniards paid scant attention to the possibilities of tilling the soil. But when it developed that there actually was little gold on the island and a serious economic crisis arose, the colonizers were forced to search for a new source of income. They took their cue from the Indians and turned to agriculture. The Spaniards then began to introduce tropical crops of all kinds and all types of farm animals. By the end of the 16th century, sugarcane, plantains, bananas, coconuts, as well as most of the domestic animals had been introduced on the island from different countries.

Production for export was the main objective, and sugar received early emphasis. In 1533, Puerto Rico made its first export of sugar—a total of 932 *arrobas*, equivalent to 23,635 pounds. Three years later the King of Spain granted a loan of 4,000 *pesos* for the production of sugarcane on the island. By 1582 sugarcane growing was the main source of income on the island, and there were 11 *ingenios* (small sugar mills), two of which were operated by hydraulic power. Those were the days when, because of lack of bullion, sugarcane and hides were used as money.

Sugar, however, lost ground in the last years of the 16th century. Output was considerably reduced by the start of the 17th century, mainly as

the result of a lack of production credit and a curtailment in the labor force occasioned by migration to Peru. Cattle hides then took the place of sugar as the principal export product.

Tobacco began to be planted commercially for export in the first half of the 17th century, after the Spanish King had repealed a prohibition on the sale of this product. During the same time, the cattle industry increased considerably in response to the export demand for hides. Ginger also had become an important export crop.

The growing of coffee was started in the highlands of Puerto Rico during the early part of the 18th century and its production was stimulated by the great demand for this product in Spain and other European countries.

By the middle of the 18th century, livestock numbers had increased to a point where there was almost a cow and a hog per capita for the island's total population of around 50,000. Cotton had developed into an important commercial crop, and corn constituted one of the principal sources of locally produced food for the people.

Up to 1815 Puerto Rico could trade legally only with Spain, but a relatively large contraband trade had developed with the Dutch and English and later with the Americans. It is believed that for many years the volume of trade involved in smuggling was greater than the legal flow of goods. A royal decree in 1815 liberated commerce from its exclusive ties with Spain and allowed legal trade with other countries. It also exempted from excise taxes agricultural implements and machinery, as well as slaves, and permitted foreigners to enter the island.

The decree opened the way for the development and exploitation that was to follow in Puerto

Rico. Encouraged by this turn in events, people began to flock into the island to take advantage of the opportunities that were in prospect. Many were brought in to add to the labor force, and these included slaves. Land clearing became more extensive and more and more soil was made to lose its fertility as additional acres were brought into production. Agriculture expanded and exports increased (table 8). The population total climbed higher and higher.

Table 8.—Exports of sugar, coffee, and tobacco, by 5-year periods for Puerto Rico, 1828–62

5-year period	Average exports		
	Sugar	Coffee	Tobacco
	<i>100 pounds</i>	<i>100 pounds</i>	<i>100 pounds</i>
1828–32	291, 892	125, 176	33, 634
1833–37	415, 144	97, 802	43, 646
1838–42	793, 283	104, 687	46, 070
1843–47	874, 046	101, 188	55, 071
1848–52	1, 052, 437	106, 990	40, 210
1853–57	1, 046, 446	116, 381	35, 268
1858–62	1, 075, 680	129, 801	50, 656

Most of the agricultural expansion was in growing sugarcane and the production of sugar along the most fertile coastal plains. This was further stimulated by the liberation of slaves in Puerto Rico in 1873. Exports of sugar from the island rose from 6 million *pesos* in 1870 to 16 million *pesos* in 1877. Then came a disaster which brought on a sharp drop in sugar exports. Diseases struck which almost wiped out the main sugarcane varieties that had been growing on the island, and large numbers of people who had depended on sugar for a living faced a desperate situation.

Many people left for the highlands where coffee growing continued to be expanded until it became a major crop. By 1897 production of coffee had increased to 51 million pounds with a value of 12 million *pesos*. The growing of coffee had been extended so that it occupied 41 percent of all the tilled land on the island while sugarcane growing had declined so much that it took up only 15 percent of the cropland. The expansion in coffee, however, did not make up economically for the decline in sugarcane production, especially in the amount of employment that was provided. And

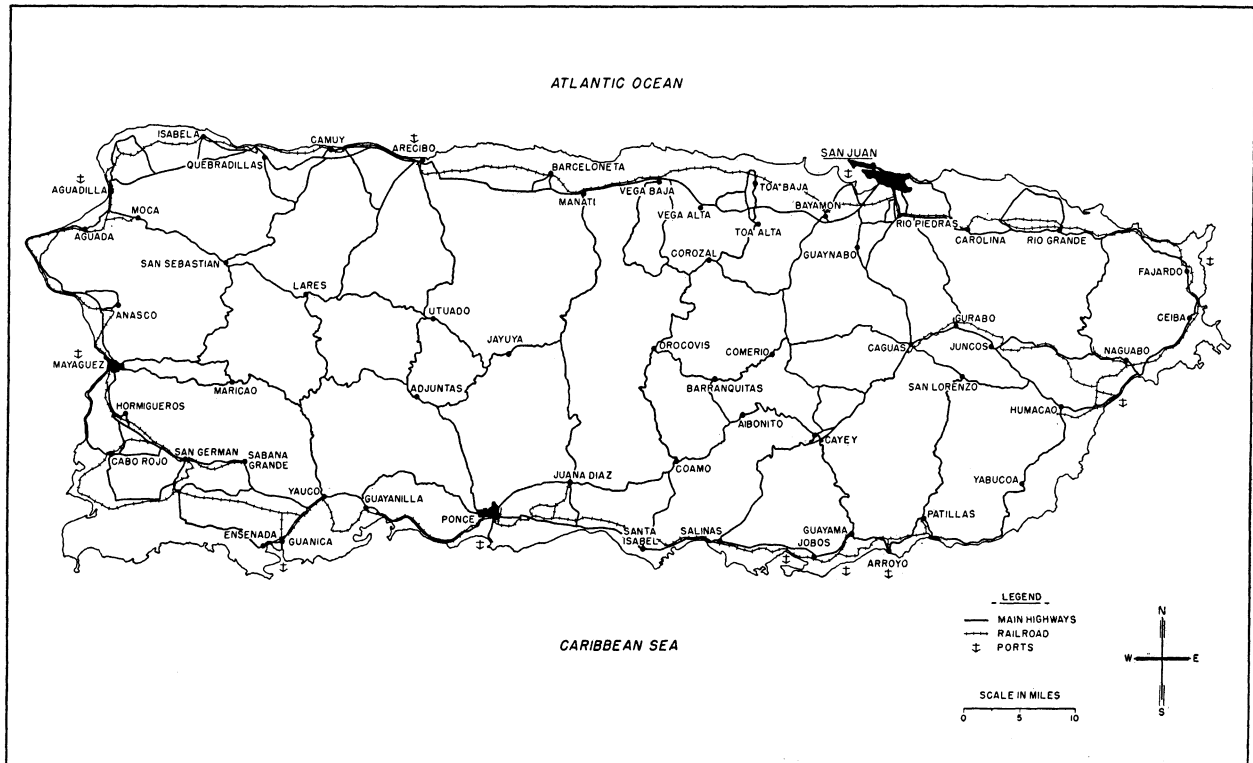
since the population had been increasing at a rate so great that it was doubling about every 30 years, the growing pressure against land resources was rapidly being reflected on both the economy and the people who, by this time, were well dispersed throughout the island.

In the first two centuries after the colonization of Puerto Rico, only the coastal areas were devoted to agriculture and only a very small portion of the land was cultivated. By and large, most of the land in the coastal plains was in pastures used for grazing livestock. As sugar production expanded through the years, more and more of this rich land went into the growing of cane.

It was during the 18th century, with the introduction of coffee, that the highlands of Puerto Rico began to be cultivated and part of the population shifted from the coastal sections to the interior. As the coffee industry expanded, an increasing number of people came to live in the mountainous interior to take up land and to find work.

The interior highland area came to be recognized as Puerto Rico's frontier since the very fertile coastal lands had already been taken over in large blocks by a relatively few owners. As the island's population increased the interior became more densely populated, not only in the western central part where coffee was grown, but also in the eastern portion. It was easier for the landless who wanted to acquire land to move into the interior, where land was owned by the Government or could be obtained at relatively low prices, than to get even a very small plot to farm in the coastal plain sections. In the highland areas not planted to coffee, cultivation of food crops for subsistence was the type of farming that prevailed.

But ready access to land suitable for farming in the highland areas did not last long. The tempo of acquisition and settlement had been stepped up greatly during the 1880's and the 1890's when the coastal regions were engaged in what appeared to be a losing struggle against the diseases of sugarcane. It soon became apparent that already there were too many people for the amount of good land available. Also, a considerable volume of land in the interior already had been acquired in large individual holdings, and this further added to the difficulties of the many who had to remain landless.



Puerto Rico with its main towns and cities and network of roads winding around the coastal plains and through the mountainous interior.

Puerto Rico Under U. S. Sovereignty

Such was the situation that prevailed in Puerto Rico when Spain's sovereignty over the island was transferred to the United States in 1898. In the first year of Puerto Rico's new status, a disaster struck which almost crippled the entire economy. On August 8, 1899, the full force and fury of a raging hurricane hit the island. Many persons were killed, and there was great devastation of homes, farms, sugar mills, roads and bridges, and crops. The island's sizable coffee industry was nearly wiped out by the storm's tremendous damage to the coffee trees and the shade trees under which they grew.

A period of reconstruction followed. With the change in sovereignty, Puerto Rico received the advantages of United States tariff protection. American capital and know-how became interested in the possibilities of the island and large amounts of both were soon invested by United States individuals and corporations. This later brought about a tremendous increase in commercial crops which could enjoy an advantage in the United States market because they would be admitted from Puerto Rico free of duty.

Sugar lands were consolidated into large-scale holdings and there also was a significant expansion in processing and handicraft activities. The big investments made possible the construction of sugar mills, as well as transportation facilities such as railroads and roads. Fertilizers and improved cultural practices were brought into use, with resultant increased per-acre yields of sugarcane. Labor was plentiful and cheap.

Once again the production of sugar for export was on the upgrade in Puerto Rico, and the crop spread out over more land. The climb in output was dramatic from the start. By 1912 it reached almost 400,000 tons, an increase of 10 times the low point to which sugar production had previously declined in 1898-99. The general trend continued sharply upward until World War I, but during the war and postwar years the rate of increase was only moderate even though prices of sugar had risen considerably.

In 1923, disease hit again and the amount of sugar produced quickly dropped back to the same level as in 1912, and again the industry faced destruction. But this time there was no waiting for a solution. Research workers and plant scien-

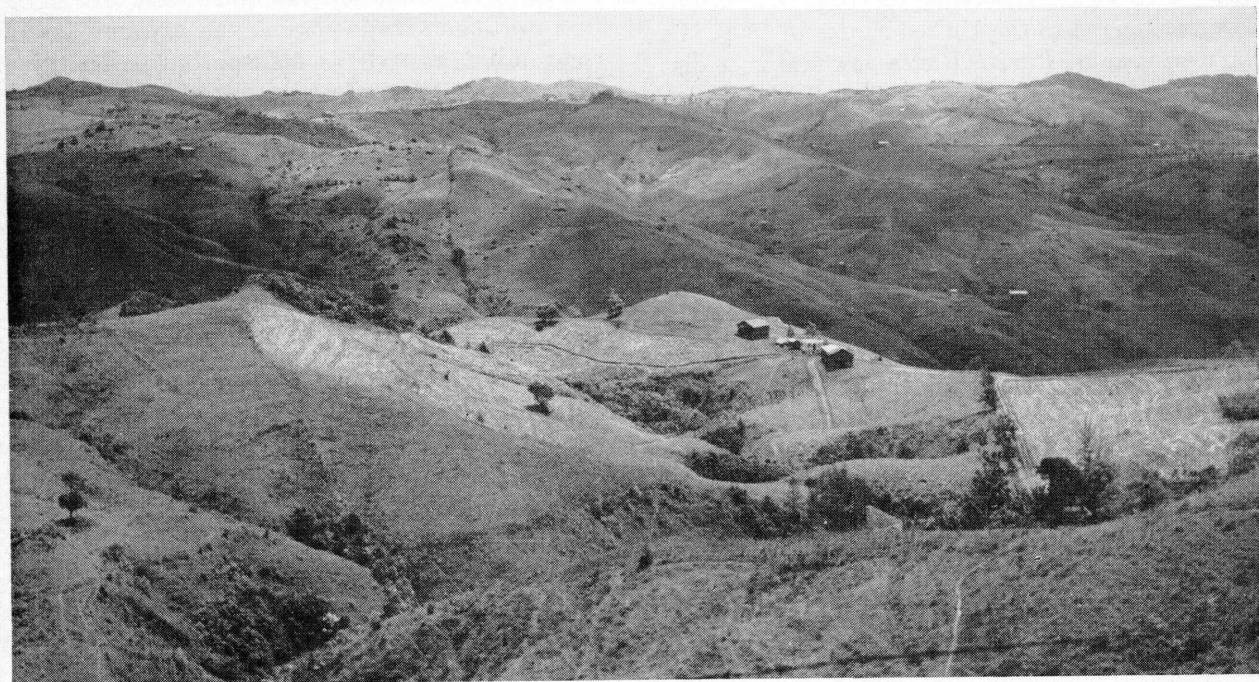
tists of the Federal and Puerto Rican Governments went to work on the two diseases that had greatly reduced yields and shortly came up with some answers. Varieties of sugarcane resistant to the mosaic and gummosis diseases were introduced, and these two plagues that threatened Puerto Rico's principal industry were brought under control. Besides, the new varieties proved more productive, and per-acre yields of sugar increased considerably.

Growers were quick to plant the new varieties, and the amount of land put to sugarcane was further expanded. Total production of sugar in Puerto Rico increased at a phenomenal rate. In 1933-34 it reached 1,114,000 tons. The value of this output, however, was reduced by the very low prices and the world-wide depression that had set in. To meet this situation, the United States Congress in 1934 enacted the Sugar Act, which imposed controls over the production and marketing of sugar as a means of aiding growers and stabilizing the industry. While Puerto Rican and other American sugar producers were helped by this action, it imposed restrictions on the sharp extension of sugarcane growing in Puerto Rico and, for a long time afterward, production on the island seldom exceeded a million tons. It is likely, however, that this would have happened sooner or

later anyhow because of the increasing competition from other producing areas.

Along with the restoration of sugar as Puerto Rico's dominant crop came an expansion of tobacco production for the United States market. Before the change in sovereignty, the outlet for Puerto Rican tobacco was confined to the island itself plus Spain, with limited exports going to other European countries such as France and Germany. Only small export shipments were made to the United States and these encountered the usual import duties. With such rather limited markets, the production of tobacco in Puerto Rico had been more or less stabilized, and during the last three decades under Spanish rule the output averaged a little over 5 million pounds a year. But when Puerto Rico came under United States jurisdiction and received the advantages of the tariff which previously had limited the entry of its products to the American market, the way was opened for tobacco to become a more important crop.

The expansion in tobacco growing that got under way was gradual for several years, but became marked in the second decade when it rose to around 25 million pounds. The American market was taking increasing quantities of Puerto Rican tobacco for the manufacture of cigars, and exports to other markets were rapidly dropping off. The



Typical of much of the interior of Puerto Rico is the Caguas area, where tobacco is a leading crop.

peak of production was reached in 1927, with a record crop of 50 million pounds grown on 81,900 acres. The big increases in tobacco were stimulated by the very favorable conditions growing out of World War I and the good demand that prevailed for cigars. But when smoking tastes shifted to cigarettes and cigar consumption declined, Puerto Rico was among the first to feel the effects.

The boom in tobacco growing in Puerto Rico came to an end with the harvest of the big 1927 crop. Prices to growers fell sharply and production was cut back to earlier levels. The industry, which consists primarily of large numbers of very small growers located in the upland areas, went into a decline from which it has never recovered although tobacco remained the island's second ranking export crop.

Also stimulated by American investments during the first three decades of United States sovereignty in Puerto Rico was the production of fruits which had acquired relative importance in the agriculture of the island. In 1929-30 exports of fruits to the United States totaled about 7 million dollars, with grapefruit and pineapple the main export items. Since that time, however, the level of such exports has declined.

The coffee industry, which had grown so important to the Puerto Rican economy under Spanish rule but which had been badly hurt by the hurricane of 1899, was not singled out for expansion with the change in sovereignty since coffee was not a tariff-protected commodity in the United States market. And without the protection of an import duty on other coffees in the United States, Puerto Rican coffee could not compete successfully in that market, since coffee from other producing areas was preferred by American consumers.

Puerto Rican coffee growers had always looked to Europe for their export outlet. But the European markets were lost largely due to the fact that the Spanish tariff, which had previously protected Puerto Rican coffee for shipment through Spain to Europe, immediately became a barrier when Puerto Rico was no longer under Spanish control. This market loss and the damage that had been done by the 1899 hurricane disheartened the growers and, lacking any specific incentive, they let coffee production follow a process of slow recovery without any special stimulus. After about a decade, coffee production had gained sufficiently to provide a substantial amount for export, and

the years between 1912 and 1915 were relatively prosperous ones for the island's growers. Then came World War I and Puerto Rico lost its European outlets. During the years that followed, exports declined sharply.

Agriculture's Role in the Economy

Puerto Rico's economy is, and probably will continue to be, largely agricultural. Most of the economic activity on the island centers around the cultivation, processing, transportation, and distribution of agricultural products. Agricultural production in 1951 accounted for about one-fifth of the total net income of Puerto Rico. The total value of agricultural production was in the neighborhood of 200 million dollars in each of the 5 years through 1951, and about half that amount came from sugarcane. The net return from farm production increased considerably since the pre-war years, from less than 40 million dollars in 1939 to around 80 million dollars annually in the 1947-51 period. The supplementary income from the transportation and marketing of agricultural products and the processing of sugar and other crops, contributes about 15 percent to the total net income of the island. Thus agriculture, directly or indirectly, provides about 40 percent of Puerto Rico's total net income.

Even though a big effort is being made toward industrialization, agriculture will continue to be the backbone of the island's economy. The reason for this lies in the fact that practically all of Puerto Rico's natural resources, as well as most of the island's economic advantages, are closely related to agricultural activity.

Puerto Rico's location in the Tropics and in the way of trade winds provides a mild climate throughout the year which is very favorable to the production of many tropical as well as subtropical crops and a variety of animal products. The island's topography, characterized by a mountainous interior surrounded by coastal plains, makes possible a good distribution of rainfall in the north of the range of mountains and permits the impounding of an ample supply of water for irrigation in the south where rainfall is not so high. At the same time, this type of topography provides a diversity of soil conditions and slight differences in climate which permit a great diversification of agriculture. To this must be added the high fertility of most of the alluvial

soils in the coastal plains and the relatively high productive capacity of some of the highland soils.

On the other hand, the island's natural resources are very scarce. Land, of course, is limited. The only natural source of fuel is hydroelectric power, which is being utilized quite effectively but meets only part of the present power needs of the economy. Except for quartz, manganese, and limited deposits of iron ore, practically no minerals have so far been found which could be rendered commercially exploitable by present techniques. Forest resources are very small.

Since Puerto Rico is so lacking in natural resources, other than those relating to agriculture, farm products provide the main source of local raw materials for industries. But, as yet, little has been done to take full advantage of agriculture as a source of raw materials in the development and expansion of industry. A closer integration of agriculture and industry is basic in terms of Puerto Rico's needs and the most effective use of available resources. Such an integration would greatly accelerate growth and diversification in both fields of activity and, thereby, broaden the economic base, improve the economy's balance, and make the island more self-supporting.

Puerto Rico is only about 2,185,000 acres in size and this area must support a population which in 1950 approximated 2,211,000 and is rapidly approaching the 2½ million mark. Since the life of these people depends so largely on agricultural production, it is imperative that the land available be used most efficiently and that conservation farming methods be employed so as to safeguard the productive resources. Actually, however, land in Puerto Rico is not being used to the best advantage and soil and water are not being properly conserved by the farming methods now employed. In fact, there is a great deal of misuse, neglect, and waste of the soil and water resources on which the economy must so heavily depend.

Measured by generally accepted soil conservation standards, less than one-third of Puerto Rico's land area is actually suited for cultivation. But the pressure of population has been so severe that it has forced the cultivation of much land with very steep slopes where erosion is acute. Altogether, about 1,900,000 *cuerdas* (a *cuerda* equals 0.9712 acre) are in farm lands of one sort or another. Of this total, there are over a million acres with 75 percent or more of the topsoil re-

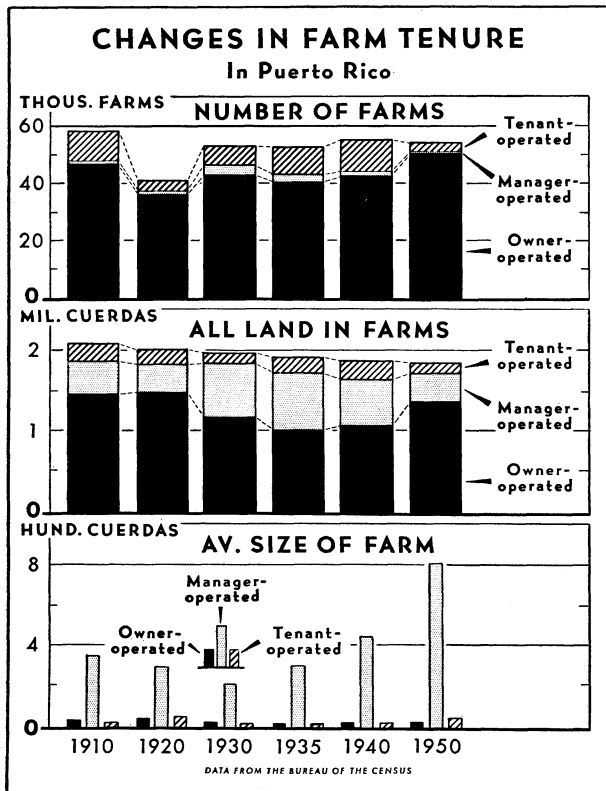
moved by erosion. Much cropland is being used intensively and the plant nutrients are not being replaced as fast as they are taken from the soil. This virtual mining of fertility results in serious soil depletion and a lowered productive capacity.

The use of improper cultural practices has greatly reduced the ability of most of the highland soils to absorb and retain water. This has added to the impairment of soil fertility. Furthermore, the lack of adequate protective cover permits a rapid runoff of rainfall with large amounts of topsoil being washed down the streams and deposited either in the sea or as silt in back of dams. The rapid runoff also results in an uneven flow of water into reservoirs and a consequent shortage of water for power or irrigation uses during the dry season.

Aside from the losses arising from unwise use of the land and water resources, the development of agriculture on the island has been affected by various other factors. Historically, Puerto Rico's agriculture has been lacking in balance. Despite the fact that the island is capable of producing a wide variety of agricultural products, a little over one-half of the value of farm production in 1950-51 was derived from a single crop—sugarcane. More than two-fifths of the total cropland and most of the best soils are planted to this one crop.

Land Tenure and Usage

As is the case in all areas where the production of sugar largely dominates the economy, Puerto Rico has a high seasonal unemployment, a small number of owners controlling the best lands, and a large number of landless people. Of the farms on the island, almost 94 percent are operated by their owners. Where landholdings are concentrated in large blocks, the organization of the farming operation tends to be highly specialized and frequently does not provide the management best suited to make the most fruitful use of all the farm land under its control. In the case of sugar production, the large size of the holdings hinders the proper utilization of such land as is not adapted or not being used for growing cane. This land could be efficiently used in smaller holdings for the intensive production of other crops and products that require day-to-day decisions and the exercise of personal ingenuity in order to become successful enterprises.



The number of farms operated by their owners has been increasing in Puerto Rico and in 1950 reached almost 94 percent of the total. This has been accompanied by a reduction in farm tenancy. The amount of land included in the owner-operated farms has also been increasing, but the average size of these farms continues relatively small. A significant trend had been the reduction in the number of manager-operated farms and the amount of land included in such enterprises. The average size of these farms, however, has increased sharply.

At the same time, because of the great pressure of population on the land, there are thousands of farmholdings too small to permit efficient operation. Altogether, a total of 104,672 holdings—53,515 farms and 51,157 *parcelas*—were reported by the 1950 census. Many of these obviously could not provide enough income to enable the farmer and his family to depend exclusively on the land (table 9). That is the situation existing for a large number of the 53,515 farms. The 1950 census classified as a farm any holding with three or more *cuerdas* on which any agricultural operation, including the keeping of 15 or more chickens or other poultry, was conducted. It is definitely the situation against which most of the 51,157 *parcelas* are up against. A *parcela* is a place of at least one-fourth of a *cuerda* but less than 3 *cuerdas* on which any crops were harvested or livestock kept. It is intended to provide a site for the home

and a little land on which to produce some food. The 1950 census shows that the *parcelas* averaged 1.04 *cuerdas*.

The pattern of land tenure in Puerto Rico shows that 58 percent of the total land in farms is contained in less than 6 percent of the total number of farms. On the other extreme, 71 percent of the farms contain only about 15 percent of the total farm land. These figures do not include the *parcelas* which contain only about 53,000 *cuerdas*.

Land use in Puerto Rico has been very greatly influenced by the fortunes of the sugar industry. Whenever the production of sugar failed to provide needed employment, people were forced to engage in other means of making a living. Many who wanted to continue in agriculture moved into the interior highland areas to work in growing coffee, tobacco, and other crops. When sugar production expanded in the coastal areas, other crops had to give way. This was especially pronounced following the change in sovereignty when, early in the 20th century, the way was being paved for a sharp increase in sugarcane production by the concentration of lands into the hands of large, mostly absentee, owners. Production of food and other crops tended to move toward the highlands as more and more of the fertile lowlands were devoted to cane.

The size of holdings in the various agricultural sections of Puerto Rico has varied with the different major crops. In the tobacco area holdings have been very small since tobacco required much

Table 9.—Distribution and size of landholdings in Puerto Rico, 1950¹

Size of holding (<i>cuerdas</i> ²)	Holdings in—		Total land in holdings	
	Parcelas	Farms	Parcelas	Farms
	Number	Number	Cuerdas	Cuerdas
Less than 3.....	51, 157	27, 985	53, 112	143, 008
3 to 9.....		10, 538		144, 449
10 to 19.....		4, 562		108, 645
20 to 29.....		4, 125		155, 075
30 to 49.....		3, 166		216, 148
50 to 99.....		1, 483		194, 155
100 to 199.....		1, 656		883, 406
200 and over.....				
Total.....	51, 157	53, 515	53, 112	1, 844, 886

¹ From U. S. Census of Agriculture.

² A *cuerda* equals 0.9712 acre.

care and personal supervision from the grower. Landholdings in the coffee area, while smaller than in the cane-producing coastal plains, have been bigger on the average than those in the tobacco area. This relationship in the size of holdings in the tobacco, coffee, and cane-producing sections has persisted up to the present.

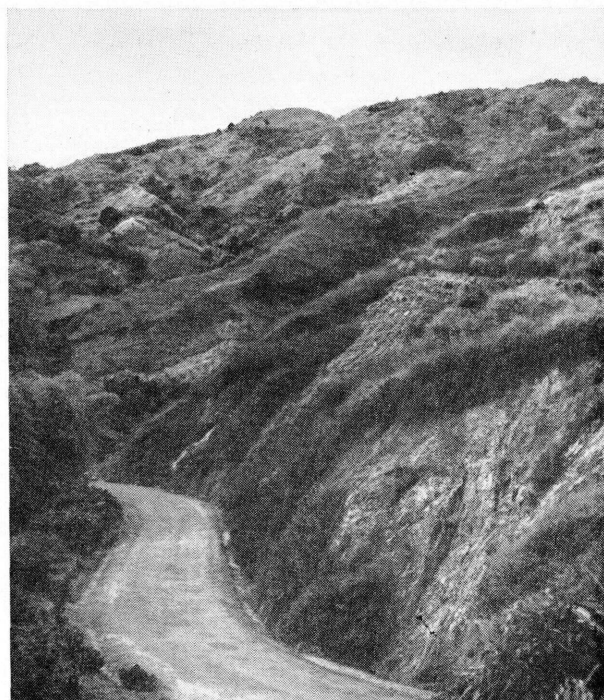
In general, the concentration of the best lowlands in the hands of a few owners had the effect of reducing efficiency in the use of those lands which were not devoted to sugarcane on the large estates. Sugarcane production was such a good enterprise and so well adapted to corporation farming, that other farm activities were neglected by the large plantation operators. Practically all land not in cane was devoted to pasture for the use of oxen needed in growing and hauling the cane. But very often the amount of land in pasture far exceeded that needed to keep the animals. As mechanization reduced the number of oxen required, more land was planted to sugarcane, or else it was left idle or in unproductive pastures.

Early in the century the establishment of government irrigation systems for the southern coast of Puerto Rico added large amounts of land for the cultivation of cane. This has had a profound effect on land use in that area.

The rapidity of population growth in Puerto Rico has naturally been a continuing factor in influencing land use. As the number of people increased, the demand for land became greater and a larger proportion of the population was forced to cultivate higher and steeper lands in the interior. This pressure of an expanding population steadily depleted vast forest areas as more and more woodland was stripped of its protective cover for the planting of crops.

The commercial uses of land in the coastal and highland areas have long been governed by various factors, the most important being (1) the availability of capital and credit, (2) the existence of protected markets, (3) the availability of factories or processing plants, and (4) the existence of transportation and marketing facilities. Virtually all of these factors at one time or another favored the production of certain export crops such as tobacco and coffee, but always sugar.

The nonexport crops have long been produced in a limited way. In the upland section, where coffee requires 5 to 6 years to come into normal production, only small amounts of food crops with



Narrow roads with many sharp curves and steep grades wind through the mountainous interior of Puerto Rico. Such roads increase farm-to-market transportation costs.

the exception of bananas and oranges, were produced in excess of the needs of the farmers and farm workers. In the tobacco area where the main crop utilizes the soil for less than half the year and permits a rotation system, food crops were planted in the tobacco fields after harvest. Thus, the tobacco area came to be the main source of local food products for Puerto Rico's growing urban population. Cereals and some vegetables, besides cattle and milk, were produced in the dry sections of the coastal plains which did not have irrigation.

Since the end of World War I there has been a tendency for sugarcane growing to be extended into the hilly lands. First the foothill areas close to the coastal plains were planted. Later, as roads and transportation facilities improved, the production of sugarcane pressed forward to the inner valleys and plateaus. Now the growing of sugarcane has been so extended that in many parts of the island it is being cultivated even on very steep slopes which previously had been devoted to coffee.

With the increase in demand for milk and the decrease in pasture lands, cattle raising has become more intensive. Dairying has developed considerably while the growing of cattle mostly for draft

power and beef has been sharply reduced. In fact, during the present century, dairying has been the only large enterprise able to hold its own and steadily increase in the coastal plains in competition with sugarcane.

As a result of the various factors that have influenced land use, the present pattern is quite different from what it was over 50 years ago. Only in the coffee areas has land use remained fairly stable. The amount of land devoted to growing sugarcane has tripled and in the last few years sugarcane growing has made inroads in certain coffee sections. In the overall land use pattern since 1940, the most drastic change has been the increase of over 100,000 *cuerdas* in sugarcane acreage, which took place largely after the end of World War II and was accompanied by a decrease in other crops. Also, there was a substantial rise in the amount of cropland used for pasture.

The pattern of land use, as indicated by the 1950 census, is about as follows: Out of a total of 1,844,886 *cuerdas* in farms in 1950, a little less than one-half was used for crops (table 10). The main crops, sugarcane, coffee, and tobacco, occupied about two-thirds of the total land used for crops and the rest was devoted to forage crops and food crops, mostly starchy vegetables, legumes, cereals, and fruits. Approximately 794,000 *cuerdas* of land were devoted to pastures most of which were natural unimproved pastures of low productivity.

Of the 768,886 *cuerdas* of land used for crops, as shown by the 1950 census, sugar occupied slightly less than half (table 11). More than 80 percent of the land used for crops in the coastal plains is devoted to sugarcane. The rest of the land which produces sugar is in the interior valleys and central plateaus, as well as in the foothills

Table 11.—Net cropland area used for crops in Puerto Rico, 1949 ¹

Crop	Net cropland area used	Percent of total net area used for crops
	<i>Cuerdas</i> ²	
Sugarcane.....	366, 441	47. 7
Coffee.....	176, 386	22. 9
Bananas.....	44, 241	5. 7
Sweetpotatoes.....	23, 818	3. 1
Corn.....	39, 497	5. 1
Tobacco.....	26, 834	3. 5
Plantains.....	15, 125	2. 0
Taniers (<i>Youtias</i>).....	14, 693	2. 0
Coconuts.....	12, 551	1. 6
Yams.....	6, 125	. 8
Rice.....	5, 342	. 7
Pineapples.....	4, 840	. 5
Cotton.....	2, 736	. 4
Other crops.....	30, 248	4. 0
Total.....	768, 886	100. 0

¹ Data based on 1950 U. S. Census of Agriculture.

² A cuerda equals 0.9712 acre.

and to some extent in the mountain areas. The number of small sugarcane growers increased considerably in recent years as cane production extended beyond the coastal regions.

Tobacco utilizes about 3.5 percent of the cropland. This crop is produced primarily in the eastern central part of the island, very often close to sugarcane fields. The food crops utilize about one-third of the cropland used for crops. They are grown mainly in the upland areas and the dry non-irrigated or improperly irrigated coastal sections. The production of coffee takes up about one-fifth of the cropped land and is concentrated in the highlands of the west central region of the island. Some of the food crops requiring a short growing period are produced by double cropping, especially in the tobacco area. There is also intercropping of some other food crops such as bananas,

Table 10.—Use of farm land in Puerto Rico, 1950 and 1940 ¹

Land use	1950		1940	
	Cuerdas ²	Percent	Cuerdas ²	Percent
Total area in farms.....	1, 844, 886	100. 0	1, 885, 874	100. 0
Land used for crops ³	768, 886	41. 7	823, 248	43. 7
Land used for pasture, including permanent pasture and wooded pasture ³	794, 864	43. 1	848, 937	45. 0
Wasteland, and land in roads, buildings, forests, swamps, etc. ³	281, 161	15. 2	213, 689	11. 3

¹ Based on U. S. Census of Agriculture.

A cuerda equals 0.9712 acre.

³ Census data covers the previous year.

plantains, and oranges, especially in the coffee area.

The best pastures are in the coastal plains. Brush pastures predominate in the coffee area, while unimproved natural pastures predominate in the tobacco section as well as in the dry unirrigated coastal plains and foothills. Pastures have been improved only to a limited extent in the dry areas and to a lesser degree in the tobacco and coffee sections. Even in the rainy coastal plains there are still large areas of unimproved pastures.

Of the total area in farms, it has been found that there are more than 200,000 acres of usable land from which no crop except natural pasture is being harvested. This virtually idle land, together with the considerable amount of land that is being only partially utilized, mostly in poor pasture, represents a waste which, in terms of potential productivity, Puerto Rico can ill afford.

Emphasis on Production for Export

For Puerto Rico as a whole, the period covered by the first three decades under the American flag was mostly one of expansion and development of production for export, primarily to the United States market. Landholdings became more concentrated in the hands of large owners and the number of landless people increased greatly as the population total climbed higher and higher each year. The growing pressure of population continued to strip the land of its fertility and its protective cover without any regard of the great damage that was being done. Under the circumstances that prevailed, there was a growing surplus of human beings, not only in relation to the amount of land available but also in relation to the number of jobs that were provided. Although conditions had improved over what they were in the past, wages were still too low, per capita income was meager, and the general level of living, in terms of any reasonable standards, continued deplorable. With the great stress on production for export, very little emphasis was given to producing more for local consumption. Thus, reliance on imported foodstuffs and other goods continued to grow as requirements of the island's population increased. Exports were needed to pay for the imports.

The general level of production in Puerto Rico increased up to 1927 and so did exports, even though export prices began to head downward shortly after World War I. Once production

really got started, the rate of increase in output became more rapid than the considerable growth in population. When this happened, standards of living improved somewhat although they still were tragically low for most of the population.

From about 1928 to 1940, however, there was a sharp drop in the general standard of living in Puerto Rico due to a combination of factors. It was during this period that the island suffered greatly from the effects of declining export prices and internal depression, as well as the two hurricanes that struck in 1928 and 1932. This period coincided with the worldwide depression, and in Puerto Rico as in the States it was characterized by bankruptcies, large-scale unemployment, and Federal relief and rehabilitation programs.

The decline in prices went to ruinously low levels for all producers, but especially pressed were those who produced for the export market. Puerto Rico's sugar industry was hit hard by the price drop although it struggled until 1934 to keep production up. Thousands of small growers who produced tobacco could not stand what for them was a violent break in prices, and after achieving a record crop they were forced to reduce their output drastically.

The coffee industry, which had made some progress in recovering from the hurricane disaster of 1899, suffered severely from the hurricane of 1928. The 1928 storm which was followed by one of less intensity in 1932, hurt production so badly that for a long time the island was not even able to grow enough coffee to meet its own consumption requirements. With world markets depressed, the price of coffee was extremely low and Puerto Rican coffee growers were threatened with bankruptcy.

The citrus industry also suffered hurricane losses and the very low prices prevailing for fruit, along with the competition from technically advanced producing areas on the mainland, eventually forced the abandonment of groves.

The Depression Squeeze

Altogether, the economy of Puerto Rico found itself in a tightened squeeze. This situation started to develop shortly after World War I when export commodity prices, especially sugar prices, began tumbling from their warborn peaks and reached the depression low in 1932. On the other hand, prices of goods which Puerto Rico had to import rose steadily during the so-called years

of prosperity in the 1920's. By around 1928 they were above the general price level that prevailed for Puerto Rican exports and continued to maintain that position until the onset of the depression forced their decline.

As long as Puerto Rican commodities could be exported at a price level that was relatively higher than the level of prices for imports, the island was in a favorable trade position. At least it was able to keep on importing the large volume of foodstuffs and other essential goods required to meet little more than the bare needs of its rapidly increasing population. But when this advantage as an exporter was lost, imports had to be curtailed at the same time that the market decline was having serious repercussions in the island's producing areas. As a result, the people of Puerto Rico had less available for consumption since from the beginning the production of more for local use had not been stressed while production for export was being emphasized. The turn of events brought into sharp focus the lack of economic balance in production that had been permitted to develop. The absence of such a cushion of production for the local market which could have absorbed some of the shock of a deteriorated external trade situation, greatly intensified the depression in Puerto Rico.

The widespread unemployment, poverty, hunger, and general decline in living conditions that engulfed Puerto Rico imposed a terrific strain on its limited resources. The depression had virtually stagnated economic activity, and a large part of the population was faced with a desperate struggle to survive. In their efforts to eke out enough to keep alive, those who had access to any land drained all they could out of it while others threw themselves onto the mercies of mankind. But as difficult as the depression period was, it nevertheless marked the beginning of some very important changes that were to have a great bearing on the future welfare of the island and its people.

First Moves Toward Recovery

Within Puerto Rico there developed a definite realization that its economic base would have to be broadened. New concepts and plans began taking shape. Most significant, however, was the growing awareness of Puerto Rico's problems and needs that was becoming evident in the United

States. Extensive activity followed the awakening that took place on both the island and the mainland. With self-help that the Puerto Rican Government could muster and assistance that the Federal Government made available, measures were put into effect to lift the island's economy out of the mire into which it had fallen.

The Puerto Rican Government employed various devices to encourage industry, improve working conditions and wages for labor, assist agriculture, develop tourism, and expand certain services essential to the economy. The Federal Government at first confined its efforts to providing some hurricane relief grants and loans. Then, during the latter part of 1933, it put into operation an extensive relief and rehabilitation program to provide emergency aid and to promote the development of the economy.

Although the activities of the Federal and Puerto Rican Governments were very helpful in mitigating hunger and need, they accomplished relatively little that would effectively broaden the economic base, give lasting strength to the foundation of the island's economy, or solve any of the basic economic problems in which excessive unemployment and underemployment were so deeply imbedded.

The Federal programs, in the main, turned out to be relief and social welfare measures, for the distress was great, and the growing population already had far outstripped the available resources as measured in terms of their customary utilization. The relief aspects were important, considering the dire situation that prevailed. To the extent that other phases of the Federal programs added to productive capacity and facilities, they did contribute to strengthening the economic base with more or less lasting effect. But the accomplishments were limited by circumstances.

The Puerto Rican Government had its own difficulties in the attempt to deal with the problems of the economy. It was weak and divided. It did not have the money and other resources needed to do a full-scale job. Also lacking was the experience as well as the imagination and know-how necessary for developing and executing the kind of programs that were required. The various shortcomings were reflected in programs that not only were narrow in scope but also lacked appeal. The weaknesses were especially evident in the measures employed to encourage industrial

expansion. But despite the deficiencies that became apparent in the whole Puerto Rican effort, a certain amount of good was accomplished for the economy by all of the programs. In addition, these activities provided some valuable experience as well as some important lessons which later proved extremely helpful.

Puerto Rico's climb out of the depression was slow and tortuous. Between about 1931 and 1935, prices for export commodities were extremely low. Prices paid for goods imported were even lower, but the people did not have enough buying power even with the vast expenditure for relief and rehabilitation that was then starting on the island.

The economic situation in Puerto Rico began to show signs of limited improvement beginning in 1935. Government money for relief, grants, loans, and other assistance increased to a heavy flow. By this time there also was definite improvement in the economic situation in the United States as a result of action taken by the Federal Government to cope with the depression on the mainland, and this also helped the Puerto Rican economy.

Puerto Rico's income from exports to the United States markets was on the upgrade once again. The principal commodity involved was, of course, sugar. Under the Sugar Act enacted by the United States Congress in 1934, efforts were being made to deal with the problems of this industry through production and marketing limitations. The incomes of Puerto Rican and other American sugar growers were being increased for, in addition to the prices received in the market, the law provided for payments which helped raise total returns to producers. Labor engaged in growing sugar also began receiving benefits because the legislation established certain conditions which growers had to meet in order to qualify for the payments. These included the elimination of child labor and the payment of fair and reasonable wages to workers.

The Sugar Act had special significance for Puerto Rico where independent growers were completely at the mercies of the sugar mills, as well as large-scale operators in the sugar business, and where labor was subject to exploitation and extremely low wages. With this new means for



The flatlands of Puerto Rico, mostly along the coastal regions, are devoted largely to the production of sugarcane. Occasionally a sugar mill looms in the background to break the monotony of a vast expanse of growing cane.

achieving greater stability in both markets and incomes, Puerto Rican expectations began to rise in the face of the marketing quota which imposed definite limits on the amount of sugar that could be sold in the American market. The income and employment needs of Puerto Rico's large and rapidly expanding production soon exerted great pressures against the marketing controls as efforts were made to continue increasing sugar production in keeping with the very pronounced trend since 1923.

Looking over the record since the first Sugar Act went into effect in 1934, it is clear that despite crop restrictions, production in Puerto Rico has exceeded marketing quotas in most years during which quotas have been in effect for the full year. From time to time this has created difficulties even though since 1934 some changes enacted at different times brought increases to Puerto Rico's sugar quota. Aside from needing a higher quota, this general situation merely highlights the continuing need for developing additional enterprises and acceptable alternatives for the use of the island's limited land and its mounting supply of labor.

But despite the many problems which continued unsolved, general recovery from the depression was well underway in Puerto Rico in 1937. Trade was very active and exports had climbed from their previous low to the highest point since World War I. Sugar production was slightly under a million tons and, being considerably in excess of the quota, the surplus added to the heavy carryover from the previous year when output also exceeded the quota.

Progress was being made in the industrial field as a result of an improved credit situation and increased lending activity in Puerto Rico on the part of various Federal agencies. Federal agricultural credit agencies also were playing a more significant role. Construction was increasing along with production, and the Puerto Rican Government further expanded electric power production and distribution facilities.

One significant development was the rebirth of the rum industry which helped increase employment and provided an additional outlet for molasses from the local sugar industry. Puerto Rico never had been a large exporter of rum, but in 1936 the value of shipments exceeded 1 million dollars and this was doubled in 1937. Rum exports made remarkable increases in the years that fol-

lowed, reaching from 6 to 8 percent of the value of all Puerto Rican exports. The peak was reached in 1943-44 when, as a result of the World War II whiskey scarcity in the United States, Puerto Rican rum shipments suddenly jumped to 35 million dollars, or about 23 percent of the export total. This also brought to the insular treasury a record income of more than 71 million dollars from local and Federal tax collections on distilled spirits. After the war, the abnormal demand for rum disappeared. Shipments from Puerto Rico dropped sharply while the large stocks of rum already on the mainland were being reduced. The low point was reached in 1947-48 when the value of Puerto Rican rum exports went below that for 1937. Exports have since increased, and it is expected that the United States market will eventually take more rum from Puerto Rico than it did in the years just before the war.

The rapid growth made by the rum industry during the prewar years was, except for the expansion in sugar refining capacity, in no way matched by the other segments of the Puerto Rican economy during this period. While 1937 was a good year from a recovery standpoint, it was followed by a considerable recession in 1938 which continued in varying degrees until the situation was changed by World War II. The United States market had weakened by a downturn in economic conditions and this was reflected in a reduced demand and lower prices. Returns from exports of Puerto Rican products dropped considerably and remained at this lower level without much change over a period of four years, until the beginning of World War II.

A New Era and World War II

In the meantime, there were developments on other fronts. First, there was the rise of a new political alinement within Puerto Rico in 1938 which grew out of the apparent lack of realism and effectiveness of established parties in dealing with the critical domestic problems of the island. Out of this came a new political party which since the election of 1940 has been kept in power by widespread popular support for its broad-gage and positive economic and social program. Secondly, there was the Federal Government's change in approach to the problems of Puerto Rico which, beginning in 1941, gave greater recognition to the underlying problems of the island and, by shift-

ing away from the emphasis previously given to relief aspects, concerned itself with building the foundations for a sounder economy and a more potent and capable local government.

These two developments marked the beginning of a new era in the economic and social affairs of the island. They tied together. Since then there has evolved a program consistent in its objective of ending the planless drift which had been so characteristic of the economy. From the very start, this program, directed at basic problems affecting the welfare of the people, gave expression to new concepts for industrial and agricultural development and the improvement of living conditions for the people.

The outbreak of World War II did not obscure the goal that was set in Puerto Rico. While doing everything possible to contribute fully to the war effort, the Puerto Rican Government moved forward with its program for land reform, economic development, and social improvement. Of course, adjustments had to be made to changing conditions. The defense program that preceded entry of the United States in the war brought to Puerto Rico a great deal of economic activity and employment. Military expenditures on the island were increasing at a fast rate. Federal relief and rehabilitation activities, which had their beginning in the great depression, came to an end. The war stimulated the demand for sugar and the burdensome surplus that had accumulated in Puerto Rico proved to be a valuable reserve for the United States. Beginning in 1942 and until the end of 1947, quotas under the Sugar Act were suspended by Presidential proclamation. Puerto Rico's 1942 crop set a new record of 1,148,000 tons of sugar.

During the war years Puerto Rico suffered greatly as the result of acute shortages arising from the difficulties of bringing in necessary imports. The submarine blockade and the lack of shipping virtually isolated Puerto Rico from the mainland. The shortages of feed, fertilizer, equipment, and other essentials sharply reduced agricultural production. In 1944 output was affected not only by lack of fertilizer and other supplies, but also by the severest drought on record. Sugar production that year went down to 724,000 tons, the smallest crop since 1927.

To make matters worse, the record drought of 1944 was followed by droughts of varying in-

tensity during the years 1945 through 1948. Partial offsets to the conditions brought about by the combination of war and drought losses were: (1) The deficiency payments made under the provisions of the Sugar Act; and, (2) the sugar purchase programs of the Commodity Credit Corporation covering the crop years 1942-43 through 1946-47.

For the crop years 1943-44 through 1947-48, deficiency payments approximating \$4,879,000 were made to 18,590 growers. The sugar output of the crop years 1942-43 through 1946-47, except for such quantities of sugar needed to meet the island's requirements, was bought by the Commodity Credit Corporation at prices ranging from \$3.46 to \$5.83, per hundredweight, f. o. b. Puerto Rican shipping port. Such purchase programs included: (1) Interest-free financing of unshipped inventories, covering up to 95 percent of the f. o. b. mill equivalent of the purchase price; (2) an allowance of 4 cents per hundredweight during the years 1943 and 1944 to cover excess costs incurred during the height of submarine warfare, when sugar shipments out of Puerto Rico could be made from only a restricted number of ports; and, (3) additional price-support payments made in varying proportions to mills and growers, over and above the contractual price, which totaled about \$35,000,000 for the years 1943 through 1947.

Because Puerto Rico had depended so heavily on imports for its food, the sharp curtailment in shipping made it essential that more food be produced on the island. In order to help stimulate food production, sugarcane growers were required to plant food crops in order to qualify for benefit payments under the Sugar Act. This was the first attempt to make the island more nearly self-supporting in its food supply, and it met with rather limited success because of the difficulties that were involved.

The problem of shortages began to ease in Puerto Rico when the war took a more favorable turn. More fertilizer and other supplies became available and production gradually began climbing upward. The output of sugar in 1945 rose to 964,000 tons. The wartime shortages of tobacco once more stimulated the growing of this crop in Puerto Rico, and exports of leaf tobacco and manufactured cigars increased considerably in 1945. The pineapple industry also started in-

creasing with the greater availability of fertilizer and the improvement in the shipping situation. At the same time, however, local food production fell off as imports became more readily available, although it continued higher than in prewar years.

Postwar Developments

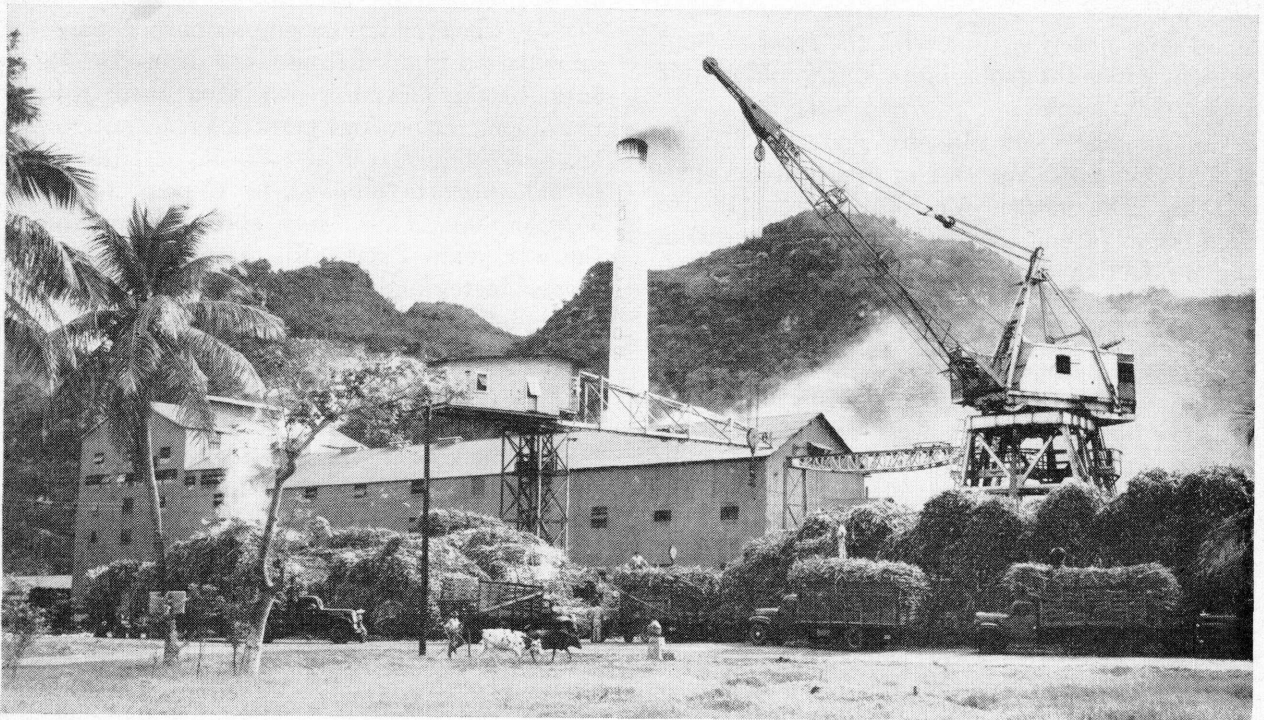
The end of World War II marked the beginning of a return to peacetime conditions, but this time Puerto Rico was in a somewhat stronger position to make necessary adjustments. At least a definite course of action had been charted for strengthening the economic foundation and progress was becoming increasingly evident out of the start that had been made. But this was nothing more than a start. Fortunately, the Puerto Rican Government has held to that view in its planning and program operations, especially since 1948 when, as a result of congressional action, the people of Puerto Rico for the first time elected their own Governor out of the party in popular favor since 1940.

All during the war years income in Puerto Rico had been increasing at a rapid rate due to heavy military spending, increased employment, and improved prices and markets for any commodities

that could be supplied. Between 1939-40 and the end of the war in 1945-46, net income from all sources in Puerto Rico more than doubled, rising from \$227,789,000 to \$565,028,000. This general trend continued into the postwar years even with the material reduction in military expenditures that followed termination of the war. By the end of 1950-51, net income for that year reached a record of \$747,000,000, or about $3\frac{1}{2}$ times the figure for 1939-40.

The general level of production began rising significantly after the end of the war. The fact that fertilizer became more readily available was an important factor in boosting agricultural output, especially of sugar for which there was a good demand due to the world food shortage which continued into the immediate postwar years. Puerto Rico's fertilizer imports doubled from prewar levels.

Sugar production on the island increased rapidly during the postwar years despite the reinstatement of marketing quotas under the Sugar Act beginning with the 1948 crop. In 1949 and 1950 Puerto Rico's sugar output was at a record high just short of 1,300,000 tons, or nearly 275,000 tons in excess of what the island could ship to the



Sugar mills are alive with activity during the grinding season. Most of the mills in Puerto Rico are quite modern and operate with a good degree of efficiency.

mainland under its basic quota after meeting local consumption requirements. Had Puerto Rico not received reallocations of deficits from other United States producing areas, and also sold some sugar on the world market, substantial surpluses would have been carried over into 1950 and 1951. The island was not so fortunate in disposing of its rather large 1951 production which came close to 1,228,000 tons. This was due to a weakening in the strong demand that developed in the previous year when hostilities started in Korea, and to the small deficits that could be reallocated. As a result, Puerto Rico had a surplus of about 120,000 tons of sugar which was carried over into 1952. This threatened to add to the difficulties expected in marketing the 1952 crop which in itself was to be of record proportions and greatly in excess of the marketing quota and local consumption requirements. At the beginning of the 1952 season, there was available for harvest over 390,000 acres of sugarcane, or about one-third more than the average acreage harvested during the 1939-46 period. It was soon apparent that, barring unforeseen developments, a heavy surplus of sugar would be carried into 1953. As a result, action was underway early in 1952 to invoke restrictions under the Sugar Act that would cut back 1953 production in Puerto Rico so that output would begin to be more nearly in line with the total amount of sugar which the quota limitations would permit the island to market.

The postwar years also saw material changes take place in other branches of Puerto Rican agriculture. The market for tobacco from Puerto Rico began falling off soon after the war ended, and production dropped sharply from the high point that was reached in 1945.

The coffee industry, which had been making some progress toward recovery, was hit by a long period of dry weather, and the 1946 crop turned out to be the smallest in a decade. As a means of helping growers, the Puerto Rican Legislature appropriated \$400,000 for subsidies to the producers. In addition, legislation was enacted establishing hurricane insurance for the coffee plantations, and this supplemented the coffee-crop insurance which was provided in the previous year. Moreover, legislation was also enacted to provide a program for the long-time rehabilitation of the coffee industry. But it was not until 1951 that, as the result of the combined efforts of the Federal

and Puerto Rican Governments started in 1949, the coffee industry of Puerto Rico showed real promise of being restored to a healthy position.

The pineapple industry, at a low ebb during World War II, began moving upward soon after the war ended. The most important development during the postwar years has been the shift in the outlets for Puerto Rican pineapples. Before the war, most of the pineapples from the island were shipped out in fresh form and canning was incidental. Since the war, the canning of pineapple has developed so that shipments of the fresh fruit could represent a relatively small proportion of the total movement of the crop.

Another significant trend has been the increase in dairying with milk production in Puerto Rico rising by about two-thirds within a decade.

The general economic situation that took shape in Puerto Rico during the war and postwar years brought about some striking developments in the export-import trade. Exports and imports had been reduced to nearly prewar levels during the most critical phase of the war when the submarine menace and acute shortages of goods needed by Puerto Rico were at their worst. But as conditions improved this trade began to increase markedly. Exports moved from a wartime low of \$92,196,000 in 1942-43 to \$161,460,000 in 1945-46 when the war ended. Imports during this same period jumped from a low of \$83,792,000 to \$242,040,000. Exports continued their general rise during the postwar years and reached a record level of \$291,000,000 in 1950-51. In this same period, imports climbed to a peak of about \$439,000,000. Thus, since about the middle of the war years Puerto Rico's trade balance has become increasingly unfavorable with the 1950-51 trade deficit of approximately \$148,000,000 also setting a new record for the island.

Lack of Economic Balance and Diversity

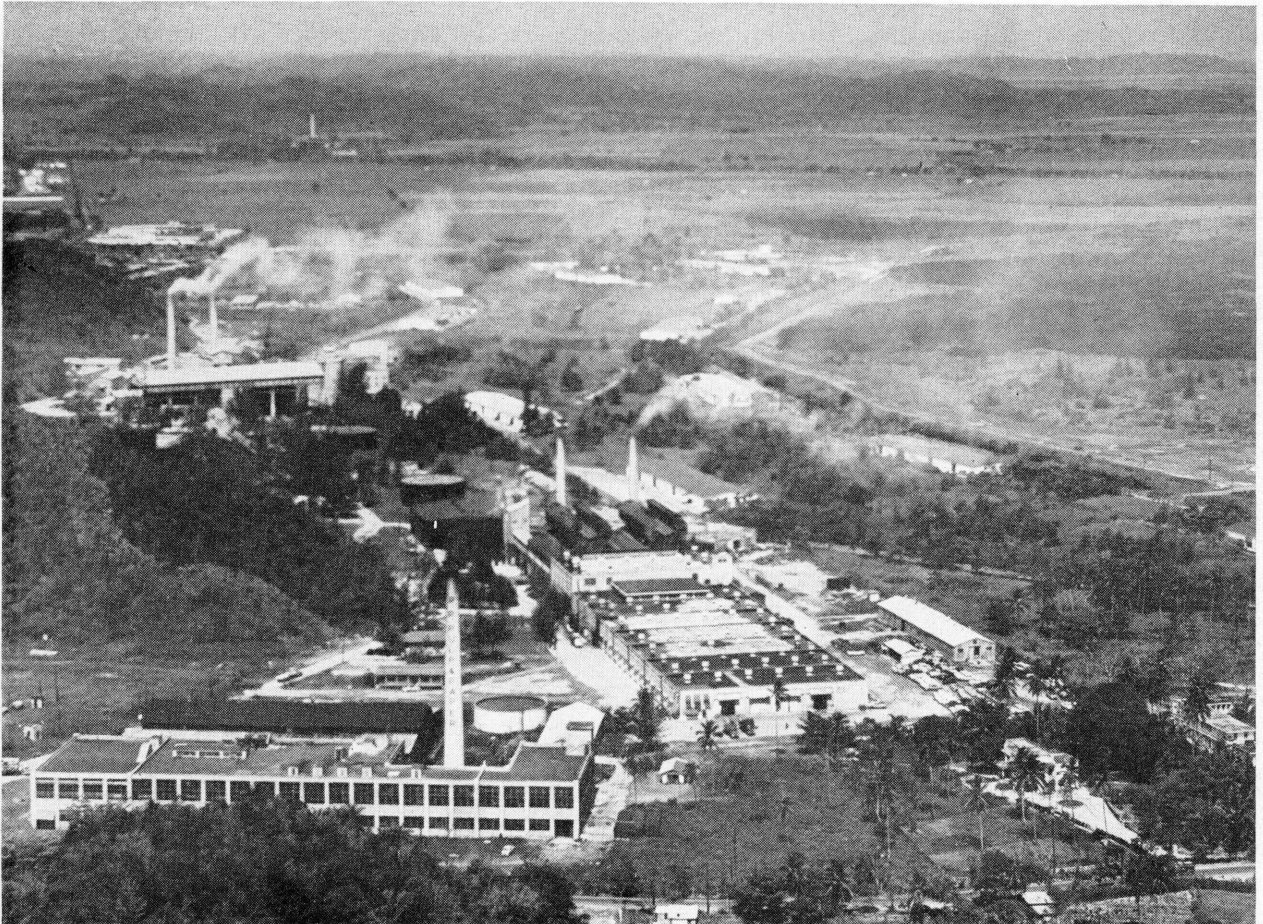
To some extent, the rise in imports over exports reflects the Puerto Rican Government's increased activity in economic development and expansion. This is indicated by the increasing amounts of construction materials, machinery and equipment, fertilizers, and various raw materials that were imported, especially in the postwar period. The rise in imports also reflects, in part at least, the general improvement in living conditions that has taken place in recent years due to

more employment and increases in incomes. This is indicated by the great postwar climb in imports of foods and other consumer goods. But after full allowance is made for all the gains, the striking fact remains that Puerto Rico's economy is still resting on a narrow base. The island continues sorely lacking in the kind of economic balance and diversification that can be attained through more effective use of its resources and opportunities.

During recent years Puerto Rico has made great strides in the expansion of business and industrial activities. The Puerto Rican Government has taken bold and courageous action in providing facilities, credit, and tax incentives for new enterprises. With the help that has been extended, the tourist trade, for example, has made remarkable growth, and the potentialities for rounded development have hardly been touched. On the industrial side more than 150 new manufacturing enterprises were attracted to the island in the 5

years preceding 1952, and encouragement has also been given to existing industries as well as to the investment of private local capital. As a result, manufacturing has become a more important factor in the economy, and in 1951 it contributed \$106,000,000, or 14.1 percent of the net income, as compared with \$26,400,000, or 11.6 percent, in 1940. But, again, far more still remains to be done to develop the industrial potential in keeping with the island's great needs.

The same fundamental weakness that has historically characterized the development of agriculture in Puerto Rico appears in the growth of its industry. Both have their focus primarily on the export market and virtually overlook the real possibilities of the local market. Of course there are some exceptions in industry as there are in agriculture. But, in general, there exists a heavy reliance on imports of many kinds of manufactured goods which otherwise could be produced economically in Puerto Rico. Obviously this im-



Industrial activity is expanding in Puerto Rico and brings with it a rising demand for raw materials and for more food to feed hungry workers. Thus additional opportunities are being opened for the development of the island's agriculture.

poses a heavy drain on the economy and deprives the people of employment opportunities. A dollar earned from exports and spent for imports disappears almost completely from the island when it is paid out. On the other hand, a dollar earned from local production and spent for local consumption or use remains on the island, and has a healthy cumulative effect on the economy as it circulates from one hand to another. Thus, if the economic base is to be effectively broadened and strengthened, it is essential that far more attention be given to increasing production for local needs to the full extent that it is economically feasible while at the same time maximizing economic production for export. This applies equally to industry and agriculture in Puerto Rico. And if followed through, it would supply the balance that is needed between both.

The industries recently developed in Puerto Rico have added to employment and buying power with benefit to all the people. The drive for further industrial expansion is being pushed vigorously. This is as it should be. In addition to increasing employment for more people, greater industrialization enables the people living in urban areas to become better customers, not only for local businesses but also for the farmers. It improves the economic balance between agriculture and industry while at the same time providing greater opportunities in both rural and urban areas. But while industrial development is moving ahead, agricultural development and improvement cannot lag behind. Agriculture must at least keep pace with expanding industry in order to provide the firm foundation needed to support industrial activity and to insure its permanency.

Under the circumstances that prevail on the

island, full and effective use of every acre of land is imperative. Also, because of the scarcity of land and other natural resources in relation to total population, it is necessary that the productive acreage be expanded through irrigation, drainage and other reclamation activities. Not enough stress can be given to the real opportunity for increasing and maintaining the productivity of all available land through the application of conservation practices, adoption of improved production techniques, and use of improved varieties and strains of seeds and breeds of livestock. To the extent that yields can be increased from present levels by these means, it is almost the equivalent of stretching the land area, and it is far less costly.

If all the land in Puerto Rico were put to its best productive use with due regard to conservation needs, the island would have a well diversified agricultural industry and a solid foundation for industrial development. This would be of far-reaching benefit to all the people. For besides directly increasing incomes and buying power of farmers and farm workers, it would contribute greatly to improving the incomes of other segments of the economy and, at the same time, boost the general level of living through an increased and more varied local supply of food and other essentials. From a practical standpoint, however, certain handicaps now stand in the way. Wherever possible these handicaps either must be overcome or eliminated to permit a fuller use of all available resources for sustained maximum production, and thus improve the standard of living and serve the best interests of all the people in Puerto Rico. It is against the complex background of the present great need that action for the future must now be viewed.

Chapter IV

The Problem of Soil Erosion

If every acre of land in Puerto Rico were suitable for agricultural use it would now provide only 0.9 acre for each inhabitant, and with the continuing rapid increase in population the total area of the island would provide by 1970 less than 0.7 acre per person. This amount of land is indeed too small even for subsistence. Unfortunately, moreover, relatively little of Puerto Rico's 2 million or so acres of land is fit for continuous farming, and the great pressure exerted by the ever-increasing population has forced into use far more land than is adapted for agriculture.

Puerto Rico's problem of too many people on too little land is greatly aggravated by the nature and the condition of the land that makes up the island. The rough and mountainous topography over much of the area definitely rules out the use of many acres for the production of food and other agricultural products. There are also many additional acres where slopes are favorable but where soil and climatic conditions further limit the safe use of such lands for continuous and profitable farming. Besides, there is the large amount of land that has been seriously impaired by erosion and depletion due to generations of human neglect and misuse.

Thus there probably is no other place in the Western Hemisphere at least that has any greater and more immediate problem to solve than exists in Puerto Rico. With a population density of about 650 persons per square mile and most of the people making barely enough to live on, the correct use and treatment of each acre of land on the island becomes an absolute necessity demanding prompt and proper attention and concerted action.

Considering the needs of its rapidly growing population, Puerto Rico has far too little land that can be safely relied upon for continuous cultivation. The work already done to determine the extent of soil erosion, soil productivity, and land capability indicates the scope and nature of the land problem that must be tackled immediately as a basic step toward establishing a healthy agriculture. Through the application of corrective measures in soil management and use, the amount of more useful and more productive agricultural land can be increased considerably in Puerto Rico.

Present Condition of the Soil

Unless hastened by man's lack of judgment through unwise land use and management, soil erosion is in itself a process that proceeds gradually toward ultimate destruction of the land's usefulness. According to the best estimates available there are only 322,500 acres of land in Puerto Rico that have not been affected by soil erosion to some degree (table 12). Another 493,000 acres have been somewhat damaged by erosion, yet with the establishment and maintenance of proper soil and water conservation practices these acres are capable of continued safe use for agricultural production. Together, these two groupings represent about 37 percent of the total area.

Of the remaining land, approximately 1,300,000 acres have been seriously damaged to the extent that their continued use will require intensive application of proper soil and water conservation practices along with very restrictive management and wise selection of the kinds of crops to be produced in order to safeguard these acres from further damaging loss or depletion. This grouping

Table 12.—Estimated erosion conditions in Puerto Rico ¹

Erosion class	Class description	Acres	Percent
0	No apparent erosion.....	322, 530	14. 76
1	Slight: Less than 25 percent of the topsoil removed.....	286, 013	13. 09
2	Moderate: 25–75 percent of the topsoil removed.....	207, 273	9. 43
3	Severe: 75 percent or more of the topsoil and less than 25 percent of the subsoil removed.....	1, 042, 602	47. 43
4	Very severe: All the topsoil and more than 25 percent of the subsoil removed.....	8, 377	0. 38
X	Condition in shallow and stony limestone soils used mainly for forest where degree of erosion is difficult to determine.....	264, 062	12. 09
—	Undifferentiated erosion—urban areas, parks, lakes, etc.....	53, 092	2. 46
	Total.....	² 2, 184, 591	100. 00
<hr/>			
	No apparent erosion (class 0).....	322, 530	14. 8
	Slight to moderate erosion (classes 1 and 2).....	493, 286	22. 6
	Severe to very severe erosion (classes 3 and 4).....	1, 050, 979	48. 1
	Shallow, stony areas with undetermined erosion.....	264, 062	12. 0
	Urban areas, parks, lakes, etc.....	53, 734	2. 5
	Total.....	² 2, 184, 591	100. 0

¹ Data from Soil Conservation Service, U. S. Department of Agriculture.² Total land area as determined by a survey made by the Puerto Rico Planning Board.

of land represents about 60 percent of the total area of Puerto Rico.

In general, the soils of Puerto Rico that have not been severely leached are quite productive, but all of the soils can be made much more productive through improved management and use. The degree of productivity, of course, varies with the nature of the soil, its formations and associations. Climate also has a direct effect on soil productivity and the island does have marked differences in rainfall as well as some variations in temperature.

Puerto Rico's soils have been classified into 115 soil series, including 352 soil types and phases, an unusually large number of soils for so small an area. The climate of the island permits a further classification of the soils into 251 types in the northern humid areas and into 101 soil types in the southern semihumid region. This variability is favorable to diversified agricultural production.

On the basis of the classification that has been made of the soils in Puerto Rico, the island has about 610,500 acres of land of general good productivity (table 13). This represents around 28 percent of the total. By far the biggest proportion of the land is of medium productivity, and this includes slightly over 1,052,000 acres, or nearly 49 percent of the total area. The remainder, which exceeds 502,000 acres, or 23 percent of the total, is considered to have a poor productivity status.

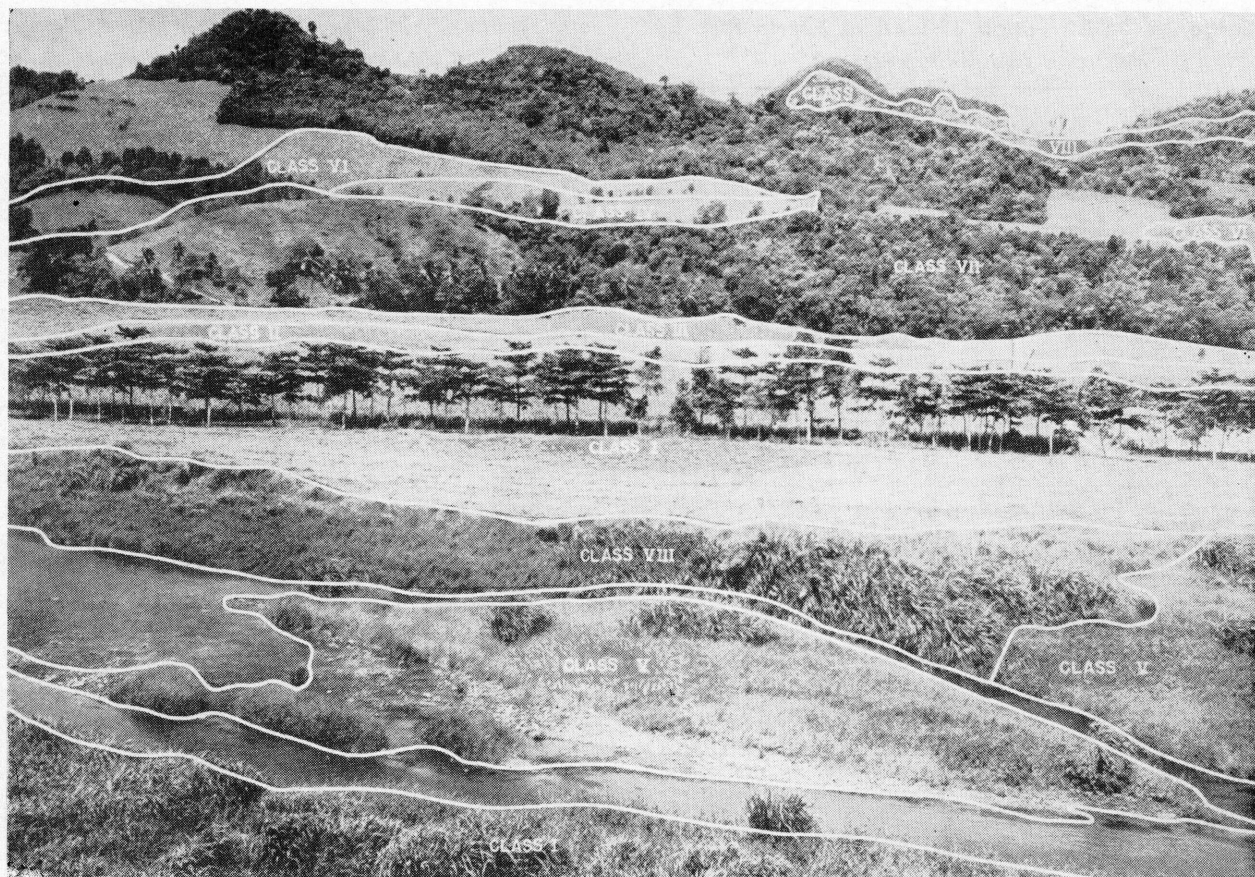
From the standpoint of productivity, the soils of Puerto Rico are deficient in certain elements, and heavy fertilization is practiced in commercial production of the important crops such as sugar and tobacco. Minerals which might be used for fertilizer are not found locally, except for lime, which is available from local sources in quantities fully adequate to meet the needs of the island although it is found only in certain sections. Where the soils tend to be acid, this condition may be easily corrected by the application of lime.

Table 13.—Productivity of soils in Puerto Rico ¹

Productivity status	Productivity ratings ²	Acreage	Percent of total area
Good.....	1–5	610, 564	28. 2
Medium.....	6–8	1, 052, 248	48. 6
Poor.....	9–10	502, 308	23. 2

¹ Data from Agricultural Experiment Station, University of Puerto Rico.² Ratings range from 1 as the best soil to 10 as the poorest.

As a result of severe weathering and parent material, about 53 percent of the soils of Puerto Rico have a clayey texture, of which about 19 percent are lateritic clays. These lateritic clays are a residual product of rock decay, friable, generally red but also yellow or purple in color, and have a high content of the oxides of iron and hydroxide of aluminum and a low proportion of silica.



Established land capability classes serve as a valuable guide to land use in Puerto Rico. There are eight classes of land. These include four classes of land suitable for cultivation and four suitable only for pasture, woodland, or wildlife. Class I is land subject to no more than very slight limitations in use; class II is land subject to moderate limitations in use for crop production; class III is land subject to severe limitations in use for crop production; class IV is land subject to very severe limitations in use for crop production; class V is land subject to only slight limitations in use for grazing, forestry, or wildlife; class VI is land subject to moderate limitations in use for grazing, forestry, or wildlife; class VII is land subject to severe limitations in use for these same purposes; class VIII is land suitable only for wildlife or recreational areas.

The characteristics of Puerto Rican soils as well as other factors such as erosion, slope, and climatic conditions are reflected in the land capability classification developed by the United States Department of Agriculture. As a guide for conservation farming it provides for the use of each agricultural acre within its capabilities and the treatment of each acre of agricultural land in accordance with its needs for protection and improvement.

The land capability classification sets up eight classes of land, the first four of which are designated as being suited for cultivation and the remaining four as not being suited for cultivated crops although useful for other purposes. In the first 4 classes, Puerto Rico has only a little over 695,000 acres suited for cultivation, of which slightly more than 91,500 acres are suited for oc-

casional cultivation (table 14). Land in these classes represents just under 32 percent of the total area. In the next 3 classes are 1,412,000 acres, or nearly 65 percent of the total, which, while not adapted to cultivation are generally suited for woodland, pasture, or tree crops such as coffee, depending upon the conditions that prevail on the particular acreage. Land in the eighth class is suited only for wildlife, recreation, or other similar purposes.

Although the general distribution of land by capability classes has been determined for Puerto Rico as a whole, the detailed classification of these soils in every part of the island has not yet been completed. Special efforts should be made to finish this land capability inventory as soon as possible. The detailed information derived from this work is urgently needed in order that farmers of Puerto

Table 14.—Distribution of land in Puerto Rico by land capability classes ¹

Land capability class ²	Approximate acreages	Percent
I.....	56, 068	2. 57
II.....	181, 204	8. 29
III.....	366, 283	16. 26
IV.....	91, 683	4. 20
V.....	69, 293	3. 17
VI.....	460, 574	21. 07
VII.....	882, 328	40. 37
VIII.....	23, 424	1. 07
Lakes.....	5, 092	. 23
Roads and urban areas.....	48, 642	2. 23
Total.....	2, 184, 591	100. 00
Land suited for cultivation (classes I, II, III).....	603, 555	27. 62
Land suited for occasional cultivation (class IV).....	91, 683	4. 20
Land not suited for cultivation (classes V, VI, and VII).....	1, 412, 195	64. 61
Land suited for recreation or wildlife (class VIII).....	23, 424	1. 07
Lakes, roads, urban areas.....	53, 734	2. 46
Total.....	2, 184, 591	100. 00

¹ Data from Soil Conservation Service, U. S. Department of Agriculture.

² Class I land is subject to no more than very light limitations in use. It is very good land that can be cultivated safely with ordinary methods of good farming.

Class II land is subject to moderate limitations in use for crop production. It is good land that can be cultivated safely with special practices of easy applications.

Class III land is subject to severe limitations in use for crop production. It is subject to serious damage from the standpoint of crop production, if used without adequate protection or treatment. It is moderately good cultivable land which can be used regularly for crops where properly treated.

Class IV land is subject to very severe limitations in use for crop production. It is fairly good land, which can be maintained best by keeping in perennial vegetation. It can be cultivated occasionally for plowed crops if handled with great care.

Class V land is not suited for cultivation, but is suited for grazing, forestry, and wildlife. It has only slight limitations in use for these purposes.

Class VI land is subject to moderate limitations. (But within class VI land there may be temporary limitations in use owing to condition of vegetation.)

Class VII land is subject to severe limitations. (But within class VII land there may be temporary limitations in use owing to condition of vegetation.)

Class VIII land has limitations that make it unsuitable for cultivation, grazing, or forestry. It has use, however, for wildlife, recreation, or watershed purposes.

Rico may be provided with sound and practical recommendations for the safe and continued use of every acre of agricultural land on the island.

Soil Fertility and Fertilizers

The soils of Puerto Rico are deficient, in varying degree, in nitrogen but they are well supplied with available potash. About 1 million acres of the acid soils of the humid area are low in available phosphorus. The soils of the humid area—and these comprise a large part of all the land—are sufficiently acid to require from 1 to 5 tons of lime per acre to correct this deficiency. In part of the arid area of the island there is a salinity prob-

lem. Some of the saline soils have been reclaimed by drainage and by washing as irrigation water became available, but there are still about 37,000 acres of saline soils in the arid area.

The farmers of Puerto Rico rely heavily on imported fertilizers, since there are no natural sources of minerals on the island that would provide nitrogen, phosphorus, potash, or sulfur. Their expenditure for fertilizer exceeds 15 million dollars a year, more than triple the amount spent in 1940. The greater part of the fertilizer supply is used in growing sugarcane. Relatively few small farmers use fertilizer or manure to offset the losses of plant food elements due to leaching and cropping. As a result plants grown on these soils to provide food and feed lack those mineral nutrients that are necessary for strong bones and teeth as well as for the general physical growth and well-being of human and animal life.

The biggest item in Puerto Rico's fertilizer bill is nitrogen, and the amount used has been increasing in recent years. About 100,000 tons of nitrogen-bearing materials were imported in 1949–50 at a cost of 4 million dollars. That same year, more than 30,000 tons of phosphatic fertilizer costing approximately \$545,000, and nearly 38,000 tons of potash fertilizers costing approximately \$1,253,000 were imported. Additional imports included sulfur and gypsum as well as over \$600,000 of mixed fertilizers. The value of all fertilizer materials imported in 1949–50 was about 7 million dollars. This jumped to over 11 million dollars in 1950–51. Ocean freight rates on imported fertilizers amounted to 46 cents per 100-pound bag and \$6.65 per ton in bulk.

Ground limestone is the common material used in Puerto Rico to correct acidity and calcium deficiency of soils. This comes from locally abundant limestone deposits. The ground limestone is sold at \$3 per ton at each of the five grinding plants operated by the Puerto Rican Government. Transportation of the lime to the farm costs a little more than \$1 per ton. In view of the need for lime on many of the soils, facilities for grinding limestone should be expanded in order to provide an adequate supply. Also, methods of grinding and distribution need to be improved so as to increase efficiency in use of the product and lower its cost.

Within Puerto Rico there is a considerable opportunity to increase the effectiveness of fertilizer and also to save on the cost of imported

materials. Studies made by the Agricultural Experiment Station of Puerto Rico indicate, for example, that a considerable reserve of phosphorus has been built up in the sugarcane soils, as the result of applications of fertilizer containing this material in excess of annual crop requirements. It is estimated that this waste through the unwise application of phosphatic fertilizer to sugarcane amounts to \$800,000 annually. Similarly, an excess of \$660,000 in potash fertilizers applied to sugarcane does not result in beneficial increases in either cane or sucrose production. Also, the waste of applied fertilizer and of soil fertility that steadily takes place through erosion and leaching, especially on sloping cultivated lands, could be greatly reduced through various control measures that would slow down the rate of runoff.

Relatively few farmers in Puerto Rico know the fertilizer requirements of the particular land they operate. Many farmers use far too little fertilizer for effective results on production. Many other farmers use mixtures which are unbalanced for their individual soil needs, with the result that some elements are applied in excessive amounts while not enough of the materials really needed are being supplied. The loss and waste entailed in this situation could be greatly reduced by the establishment of a soil-testing and foliar-analysis service that would make the necessary diagnosis and provide farmers with recommendations as to the fertilizer requirements of their own soil for the crops to be grown. Such a service could be provided by private or cooperative action. Also, it could be set up by the Puerto Rican Government and, if so, should operate on a self-supporting basis with fees charged to cover the cost of the necessary sampling and testing done for the farmers. Besides resulting in direct savings to farmers and contributing to increased production, such a service in Puerto Rico would be helpful in general soil research and diagnostic work.

Various studies indicate that, on an overall basis, Puerto Rico can effectively use considerably more fertilizer than is now being employed in the production of crops and pastures. Through the years there has been a great loss of various fertility elements on most cultivated lands, especially those in the humid sections where leaching is most severe. The deficiencies that exist, such as the phosphorus deficiency in the red soils of

the coffee area, must be corrected and protective measures employed in order to make the land more productive. But, in addition, it appears that Puerto Rico could benefit greatly by the use of much greater quantities of nitrogen than are now being applied in the growing of crops. The total use of nitrogen for many crops, including sugarcane in some areas, could be more than doubled from the present average rates of application and, with adequate phosphorus and potash, the increases in yields would far more than compensate for the extra cost involved in applying the additional nitrogen. Proper land use and conservation practices would assure maximum benefits from the improved use of fertilizers.

If it were economically feasible for nitrogen to be produced in Puerto Rico, there would be a considerable saving to the island. In addition, the manufacture of nitrogen would provide the basis for a chemical industry which would be helpful to the entire economy. The possibility of establishing a nitrogen plant in Puerto Rico should be kept under constant review in the light of any developments, such as in atomic energy, which may permit economic production of this element on the island.

Much can be done to improve both the fertility and the condition of many of the soils in Puerto Rico by growing soil-building legumes and grasses. In addition to furnishing a protective cover for the soil against erosion and leaching, legumes and grasses provide valuable balanced livestock feed. Very little use is now being made of legumes and grasses for soil building purposes despite the established fact that these plants can make a substantial contribution to the improvement of agriculture on the island. Where acid soils exist, liming is necessary to help nitrogen fixation by legumes and to increase the rate of nitrification.

Soil Organic Matter

In general, soil fertility is associated with a continuous supply of organic matter maintained in the soil. This vital substance is, under natural conditions, replenished from the plant material that is grown both above and below the surface of the soil.

Most tillage practices tend to reduce the supply of soil organic matter as the soil microorganisms feed on organic matter and cause its rapid decom-



Much of the interior of Puerto Rico is deforested. In the northern foothills near Ciales, for example, slopes which 20 years ago bore coffee plantations beneath protective tree shade are now bare.

position into its simplest elements. In this form it is either consumed by the growing vegetation or is lost through leaching. As most cropping removes the vegetation that is produced, a situation is thus created where the supply of soil organic matter is maintained at only a low level, with consequent decreases in the quantity and quality of the crop that is produced.

Large accumulations of soil organic matter by either natural or other processes do not occur in Puerto Rico. This situation arises largely from the climate but it is also the result of some of the practices employed on farms. One damaging practice is the burning of trash, such as sugarcane tops, in some fields. This practice not only destroys valuable organic matter which otherwise might be returned to the soil, but it also sears the surface of the land and results in the destruction of organic material and microorganisms that may be mixed with the soil particles. In addition, it promotes erosion. The practice of clearing land by burning should be prohibited by law. No organic matter, no matter how small the quantity, should ever be destroyed by burning. It should be

used as a mulch or else incorporated into the soil for future use by the vegetation growing upon the land.

Cultivation of Sloping Land

Except for the coastal plains, most of the land in Puerto Rico is hilly or mountainous. Some of the land consists of gentle, rolling slopes, but much of it is steep. In some parts of the island these steep slopes form very narrow V-shaped valleys separated by razor-back ridges. This is the kind of land, hilly in the main, that makes up the greater part of the island's interior, with elevations running from a little above sea level to more than 4,000 feet, with climate ranging from arid to humid. The soil characteristics vary widely from rich to poor, from alkaline to acid, from old to young, from deep to shallow, and from heavy clays to coarse sands.

The steadily increasing population and the resulting pressure for more and more lands to cultivate have forced people to use steeper and steeper land. This has resulted in the clearing, the use for cultivation for a limited time, and the final aban-

donment of strongly sloping lands that never were suitable for tillage. Throughout the island this cycle repeats itself as the pressure of population increases. This pressure forces abandoned land back into use for cultivation—and it will only be abandoned again as soon as it once more becomes exhausted.

Almost everywhere in Puerto Rico there is a lack of consciousness as to what constitutes proper land management and good land use. Clean-cultivated crops are grown without regard to the steepness of the slopes or the care that is needed to safeguard the land against erosion. As a result, there is a great loss of surface soil, which after each heavy rain is washed down the streams and rivers in tremendous volume. This unwise handling of the land has damaged more than one-half of the land surface of Puerto Rico. Even though many of the soils are very heavy clays, the intense rainfall over much of the island has each year caused great losses, in organic matter, in fertility, and in soil itself. The effects of these losses are reflected in crop production and the standards of living and health for the many people who are and have been dependent upon the soil for their very existence.

The deplorable waste of soil resources that has taken place for so long a time need not continue. In fact, it cannot be allowed to continue if any significant improvement is to be made in the agriculture of Puerto Rico and the living standards of the people. With the correct conservation treatment and management that is necessary to prevent damage or deterioration, the soils of Puerto Rico can be made more productive and more lastingly useful. But first there must be a great awakening to the present danger and the urgent need that exists for overcoming this waste.

The relatively few farmers in Puerto Rico who operate their land with all of the care that is necessary to safeguard its future usefulness and increase its productivity are located mostly along the coastal areas and in the wider valleys, where the surface is mostly flat and the problems are primarily those of drainage. The soil problems on the rolling and steeper slopes are more numerous and more complex, yet the attention paid to them is pitifully little. This situation prevails despite the fact that much of the protection needed by the land can be supplied by employing inex-

pensive farming practices, using rather simple mechanical methods, and growing vegetation.

Under the conditions that exist on the rolling and hilly lands of Puerto Rico there is a great need, for example, to conserve water for plant growth and at the same time to reduce runoff to prevent erosion while also assuring adequate drainage. The use of terraces, the practice of contour farming, stripcropping, and the use of grasses and legumes all have their place in dealing with these problems but their possibilities are being overlooked by most farmers. Along with other good farming practices, these tested methods of soil conservation need to be brought into widespread use in Puerto Rico so that the farmers who utilize them and the people as a whole may benefit from the gains that can be made in holding the soil in place and increasing its productiveness.

Sugarcane Problem on Slopes

Most alarming in recent years has been the marked tendency for the growing of sugarcane to spread into the hilly sections of the island, bringing into cultivation sharply sloping lands which are subject to dangerous erosion and depletion. Thousands of acres have been stripped of their former protective cover for the planting of cane on soils which should not be tilled but which could be maintained permanently productive and profitable by their proper use for permanent cover crops. To make way for the temporary gain expected to result from the growing of sugarcane on these lands, farmers have cut over, plowed up, and destroyed woodlands, coffee plantings, and pastures with reckless disregard of the ultimate consequences on their own future well-being and the soil on which people must depend.

What has been happening represents a major change in land use. It endangers permanent sources of income and wipes out more stable plantings which provide indispensable protection against the destructive forces of erosion and depletion. Altogether, approximately 50,000 acres of land have, in 1950 and 1951 alone, been shifted over from woodland, coffee, and pasture production to the cultivation of sugarcane. Far more than half of these acres represent land on which permanent cover should be maintained in order to prevent serious damage and loss through erosion and depletion. This same situation prevails on many more acres growing sugarcane.



The production of sugarcane has crept up from the coastal plains into the hilly sections. In the years immediately following World War II, with a good market for sugar and readily available credit for its production, much cane was planted on steeply sloping land at the expense of other crops.

A land use study made in 1951 by the Puerto Rican Department of Agriculture has brought to light some startling facts regarding the extent to which sugarcane was being grown on sloping land and the steepness of the slopes employed. This study covered 35 municipalities with a total of 206,000 acres of sugarcane, or about half of the cane acreage of the island. The study revealed that 30 percent of this acreage represented plantings of cane on lands sloping 16 percent or more. This included about 33,000 acres of cane planted on slopes of from 16 percent to 35 percent, 17,000 acres on slopes of from 36 percent to 59 percent, and nearly 12,000 acres on slopes in excess of 60 percent.

From a land capability standpoint, lands with more than 40 percent slope are regarded as being unsuited for clean cultivation because they generally erode easily and severely. They are lands that demand careful management, and are suitable only for growing crops that do not require tillage but which protect the soil against being washed

away by the rains. In view of what constitutes wise land use, the growing of a tilled crop like sugarcane on such sharply sloping soils represents nothing more than a shortsighted abuse of resources that is wasteful to the economy and detrimental to the best interests of the farmer himself as well as to Puerto Rico as a whole.

Much of the sloping land that has been turned into the growing of sugarcane does not produce a large tonnage of cane. In most instances the number of tons per acre will fall below the island average. Also, the cost of producing cane on the slopes is higher, since more labor is involved and the soil usually is not so fertile as in areas better suited to sugar production. Nevertheless, sugarcane has moved up into the hills and displaced crops that are more desirable from the standpoint of good land use and conservation.

The reason for this may be found in the fact that (1) sugarcane is a relatively easy crop to grow, (2) since the beginning of World War II and until 1951 there has been a ready market avail-

able to growers, and (3) in addition to the price that growers obtain from the sale of their sugar in the market, they receive payments under the Sugar Act which add to their income from sugarcane growing.

The system of Federal payments under the Sugar Act helps minimize the income risk, and for many smaller farmers this has been among the several compelling forces encouraging them to strip the steep hillsides of their protective cover in recent years to plant cane. This has taken place despite the reinstatement of sugar marketing quotas beginning in 1948. Actually, the area of steep land put into sugar production in Puerto Rico never has been greater than during the 5 years from 1946, and the sharpest increases were in each of the last 3 years of that period.

The base rate of payment to each grower under the Sugar Act is 80 cents per 100 pounds of sugar, raw value. This is the rate paid when sugar production on an individual farm is up to 350 tons. The rate is scaled down to 75 cents on production from 350 to 700 tons, drops to 70 cents per 100 pounds on production from 700 to 1,000 tons, and then declines at specified intervals until the payment reaches a minimum of 30 cents per 100 pounds on production of more than 30,000 tons. Also authorized under the Act are payments for bona fide abandonment of planted acreage and crop deficiencies of harvested acreage, resulting from drought, flood, storm, disease, or insects, which cause damage to all or a substantial part of the cane crop. To qualify for any of the payments, growers must meet certain conditions, but these relate primarily to compliance with farm marketing allotments, child labor, and minimum wage requirements.

For the smaller growers the rate of payment affords quite an incentive for the production of sugar in preference to other crops. The fact is that it has been extremely difficult to induce these farmers to improve their coffee plantations or engage in other desirable land use enterprises as long as they had any prospect of being able to convert their land to the growing of sugarcane. This situation has prevailed even though in the long run, with the right kind of management, the coffee and other production activities could be made to return more than sugar would on the same land.

The Sugar Act payment in Puerto Rico, based on yields of sugar produced and rates of payment per 100 pounds, raw value, averages about \$47 per acre. On the 1950-51 crop these payments totaled more than 17 million dollars. This is ready, cold cash added to the market return from the sale of sugar produced. Even though it may be argued that the Sugar Act payment should in reality be considered as being part of the price received from the sale of sugar, the fact remains that the payment is separate from price and is made as fixed regardless of what happens to the market price of sugar. Since the fixed payment on sugar produced minimizes the gamble of producing sugarcane, this crop has been planted on hilly soils that never should be cultivated.

In the circumstances prevailing up to now, the returns from sugarcane, together with other factors such as the availability of financing, have presented formidable obstacles in any effort that might be made to induce farmers not to grow sugarcane on lands that should otherwise be employed and protected. The Federal and Puerto Rican Governments are making efforts and spending many dollars to promote conservation and encourage wise use of the island's limited resources. Since the proper use of land is not a specified condition for payment under the Sugar Act, the Federal Government has been forced into an untenable position insofar as the situation in Puerto Rico is concerned. In this particular instance, the left hand is destroying what the right hand seeks to accomplish on the sloping lands where the erosion problem is most acute. This calls for a reconsideration of policies with respect to conservation efforts and conditions for payment under the Sugar Act.

Since Sugar Act payments are made separately, this provides a device which could be employed effectively for the proper use of land resources. The establishment of a general policy under which henceforth no payment would be made to any grower whose sugarcane was produced on land which, on the basis of steepness of slope and soil composition, is subject to an undue amount of erosion under cultivation would contribute greatly to proper land use and the conservation of scarce resources in Puerto Rico and help strengthen not only the agriculture of the island but the entire economy. In the case of hilly land already growing sugarcane, the farmer, in order

to qualify for the sugar payment, should be required to employ such land-use practices and treatments as may be prescribed by the soil conservation technicians and also agree to restore a suitable protective cover to that land right after the present planted cane becomes exhausted. This, of course, would require an amendment to the current Sugar Act.

Puerto Rico has an adequate amount of really good land that is suitable for the production of sugarcane without having to tear up the steep sloping hills to grow this crop. Those good lands should be used more intensely for sugarcane for they are capable of producing with greater efficiency far more than the record output that has been achieved for the entire island up to now. The hilly lands have other valuable uses and they have their own contribution to make.

Sedimentation of Reservoirs

A number of the streams and rivers of Puerto Rico have been harnessed for the production of electric power and to supply water for irrigation and other purposes. The water from these streams and rivers is stored in reservoirs for use as needed. The island so far has 17 hydroelectric plants with a total capacity of 96,575 kv.-a. (kilovolt-amperes) and 4 steam-electric plants with a total capacity of 123,087 kv.-a. The power developed from the streams in Puerto Rico totals some 230 million kilowatt-hours per year out of a potential estimated at about 700 million. Projects already under construction are expected to bring the total electric power developed from streams and rivers up to a total of about 350 million kilowatt-hours in the near future. The amount of land under irrigation, about 100,000 acres, will also be increased by the completion of these projects.

The use of electric power in Puerto Rico has been increasing very sharply since the prewar years. Production of power during 1950-51 exceeded 620 million kilowatt-hours, compared with an average of only about 128 million in the 1935-40 period. Requirements for electric power are continuing to increase at an average rate exceeding 70 million kilowatt-hours annually.

Through its use for irrigation and power purposes, water plays an important role in the economy of Puerto Rico. But the natural supply of water on the island fluctuates markedly from one time of the year to another on account of the sea-

sonal distribution of rainfall. Thus, in order to have ample supplies of water available at all times, it is necessary to provide reservoirs which collect and conserve runoff during the wet season so that the requirements for water during the dry season may be met.

The sites available for reservoirs are definitely limited in Puerto Rico. Once a reservoir is built, it immediately assumes the importance of an irreplaceable facility. Its value to the economy depends on how long it will maintain enough storage capacity to impound water for power, irrigation, and other public needs. In this connection, the amount of sedimentation that takes place as the streams and rivers empty their waters into the reservoir becomes immediately and especially significant.

Detailed information on reservoir sedimentation in Puerto Rico is rather meager. Nevertheless, it is clear that the rate of sedimentation ranges from an almost negligible amount for the reservoirs high in the mountains to very severe silting for reservoirs in the lower regions. Geological conditions on the island are such as to be favorable to a rapid rate of erosion. But the balance between natural forces has largely been overcome by the destruction of forests and the cultivation of steep slopes with the result that the rate of erosion has been greatly increased. Where this has taken place, the streams and rivers are usually loaded with soil that is carried from the land by the runoff after each heavy rain. When these arteries empty into a reservoir, they deposit the sediment that has been carried down from the ravished hillsides. As this sediment piles up in the storage area, it reduces the amount of water that may be impounded and lowers the value of the reservoir. Thus the accelerated erosion that has been induced by man poses a really serious problem and endangers the future usefulness of the island's freshwater resources for power, irrigation, and other needs.

What actually has been taking place in some parts of the island is shown by recent estimates of sedimentation in the Guayabal, Comerío, and Coamo Reservoirs (table 15). The Guayabal and Coamo Reservoirs were built to supply water for irrigation purposes while the Comerío Reservoir was constructed to furnish water for the production of electric power. Since they were completed in 1913, the amount of sediment deposited in these

Table 15.—Sedimentation in three reservoirs of Puerto Rico

Name of reservoir	Original water storage capacity	Area of watershed	Condition by 1950			Average annual rate of loss in capacity
			Age	Estimated sedimen- tation		
				Volume	Percentage	
	<i>Acre-feet</i>	<i>Square miles</i>	<i>Years</i>	<i>Acre-feet</i>	<i>Percent</i>	<i>Percent</i>
Guayabal-----	9, 544	43. 4	37	4, 750	49. 7	1. 34
Comerio-----	4, 918	133. 0	37	4, 318	95. 9	2. 59
Coamo-----	2, 687	58. 0	37	1, 887	70. 2	1. 89

reservoirs over a period of 37 years has reduced their storage capacity at rates estimated as ranging from 1.34 to 2.59 percent a year.

The accumulation of sediment in the Guayabal Reservoir between 1913 and 1950 reduced storage capacity by about 50 percent. This brought on a shortage of irrigation water in the western section of the South Coast Irrigation District which was detrimental to agriculture. In order to restore the initial capacity of this reservoir, the crest of the

dam was raised an additional 16 feet in 1950 at a cost of about 2 million dollars. But nothing has as yet been done to reduce the rapid rate of sedimentation which made raising of the dam a costly necessity.

Siltation in the Comerío Reservoir has been very severe. It is located in an intensely cultivated hilly agricultural area with about 75 inches of rainfall annually. The altitude of the watershed that drains into this reservoir varies from a



The Comerío Reservoir has lost almost all of its original water storage capacity because of sedimentation. This view shows the large delta formation at the head of the reservoir.

little more than 350 feet above sea level to slightly over 2,900 feet. The amount of sediment flowing into this reservoir has almost completely destroyed its usefulness for the production of electric power. The Coamo Reservoir is similarly located, the altitude of its drainage area varying from about 330 feet to 2,950 feet above sea level. Within a 37-year period sedimentation reduced its original capacity to store water by an estimated 70 percent.

Several other reservoirs are located considerably below their watersheds. Although detailed surveys have not been made, it is apparent that they too have their sedimentation problems in varying degrees. The Caonillas Reservoir, the largest on the island, was completed in 1948, and already a considerable amount of sedimentation has taken place. Also, a long delta is already forming in the upper end of the Dos Bocas Reservoir which was completed in 1942.

The importance of conserving and thereby prolonging the usefulness of the irreplaceable water-storage capacity of every reservoir on the island must be stressed again and again. Puerto Rico now is heavily dependent on stored water for irrigation, power, and other purposes. This dependency is increasing year by year, but the land sources from which water may be drawn and the natural areas for storage are limited. Yet, despite this situation, there is no complete program operating for the conservation of the water supply and storage resources which are so vital to the economy.

The typical dam in Puerto Rico has been built largely on the basis of whether it would amortize its cost within an estimated period of usefulness determined by such factors as prevailing conditions affecting erosion and possible sedimentation. Once it was reasonably certain that the expenditure would be returned within the estimated period before siltation destroyed the water storage area, construction of the dam was ready to start. Whether any thought was given to measures that might initially be taken to prolong the estimated life span of the reservoir is academic, since nothing of the sort that would provide adequate watershed protection or treatment has actually been carried out as an integral part of such a project.

The ample experience with reservoirs in Puerto Rico makes it clear that under the conditions that prevail, the building of a dam in the lower regions ahead of watershed protection work in the up-

stream areas is like putting the cart before the horse. Of course, a certain amount of sedimentation caused by geological erosion cannot be stopped, but the big problem awaiting attack in most of the watersheds above reservoir locations is the accelerated erosion caused by man. To provide the necessary watershed protection, work must be started even before construction of a dam begins. It must be carried through continuously after the reservoir is in operation and adjustments made in the methods employed as changing conditions may require. Soil, plants, and water are so interdependent that all three must be considered in managing a watershed for the greatest public benefit.

The agency of the Puerto Rican Government that is primarily responsible for the various aspects of water and energy resources conservation, development, and utilization is the Puerto Rico Water Resources Authority, a public corporation established by the Legislature. This agency has done an excellent job in developing the water and power resources of the island. But the various activities have not been properly balanced so as to make adequate provision for watershed protection in the planning and maintenance of water development and reservoir projects.

The fact that a dam will amortize its cost by the time sedimentation destroys its usefulness is important from the standpoint of investors who may finance the project. It also appeals to the public. But by merely reaching this point the project does not serve the public interest in full measure. It does not deal with the question of what can and should be done to prolong the life span of a reservoir so that it may continue to render good service for a period far greater than the number of years estimated for amortization purposes. This should be of paramount public concern in Puerto Rico in view of the scarcity of natural damsites and the great need that exists for prolonging the useful life of those that are available.

Of course, the cost of applying adequate watershed protective measures must be taken into consideration and weighed against the benefits that would accrue. However, a great deal of what needs to be done can be accomplished with a relatively small expenditure of funds on some things and without spending any money on others. All of the possibilities need to be explored.

The full burden of the watershed work does not necessarily have to be borne by the Water Resources Authority. It should, however, provide the leadership that will permit an adequate job to be done in the watershed and reservoir areas. Various other governmental agencies in Puerto Rico deal directly with soil and water conservation and forestry problems, and they also work with farmers. Those agencies are in position to contribute materially to the success of a well-rounded watershed program. The help that is available from them should be more effectively utilized by the Water Resources Authority both in planning and executing watershed treatment and protection measures. As a basis for cooperative action, the Water Resources Authority might find it desirable to enter into a working agreement with all of the agencies that would be involved

so as to arrive at a definite understanding of the responsibilities that would be shared by each in moving forward with a watershed program.

In some instances, it may be necessary to resort to regulatory measures in order to stop destruction arising out of unconscionable waste and misuse of limited natural resources. For example, tilling of steeply sloping land right up to the very edge of a reservoir certainly hastens the time when this water storage facility will be ruined by sedimentation. On the other hand, the growing of grass, trees, or some other permanent cover over a fixed area starting away from the water line would afford protection from silting and at the same time not deprive the owner of the use of this land. Help could be provided to farmers to make the necessary adjustments in land use practices. In some of the more important watersheds, it might be desirable



One of the more recent sources of hydroelectric power in Puerto Rico is the Coanillas watershed and lake. Lands sloping as sharply as those in this watershed require adequate protection against erosion in order to prevent rapid sedimentation and eventual destruction of the reservoir.

for extremely critical areas to be publicly owned, with perhaps a form of zoning to permit proper management and use of such lands by the people who live on them. Such a zoning system might also be desirable for critical areas under private ownership, so as to prevent seriously destructive land use and cropping practices.

No matter what course is followed, the fact is that it must be suited to the needs of the particular area and the problems that must be met. With the proper approach it should be possible to develop the understanding that is necessary for the support and cooperation required in the successful operation of any program.

Beach Erosion

Surrounded as Puerto Rico is by sea water, the coastal areas are subject to erosion as the result of action by winds and waves. Along the northern coast there are many wide bays, and the beaches bordering these bays are formed by unconsolidated sands. When the littoral east-west currents are affected by high winds and storm waves, sections of these beaches are subjected to wave erosion and sometimes wide areas are completely washed out.

These conditions occur along practically all the sandy northern coastline. The worst damages, however, occur in a coastal stretch east and west of Luquillo: At Palo Seco where recently a village was isolated because a section of the only road leading there was washed out, at Dorado, at Barceloneta, and at Arecibo where pounding waves have on several occasions resulted in much loss. Also, along the western coast on the beach running south of Mayagüez, high winds and storm waves have done considerable harm, and Insular Road No. 102 has been badly damaged several times.

The coastline erosion problem has been greatly aggravated by the destruction of vegetation. Where vegetation has remained untouched, some degree of protection is provided against the forces of wind and water. This helps to reduce the amount of erosion that takes place.

Another practice that has dangerously increased the beach erosion problem is the removal of sand from the beach area for building purposes or for filling wet or marshy sections in the metropolitan areas. This is having a detrimental effect on the shoreline extending from San Juan eastward



Sand dunes along the northern coast of Puerto Rico near Arecibo. The removal of sand from this and other coastline areas has aggravated beach erosion.

to the mouth of the Río Grande de Loíza. In the vicinity of Arecibo, much sand is being removed from the coastline sand dunes near the new port facility with the result that the land area around the port is being endangered.

The removal of sand from beaches should not be permitted where the consequences would be harmful. Since sand is continuously being removed from beach areas without regard to potential damage, consideration should be given to control of this practice through some regulatory measure that will provide the needed safeguards.

Soil Conservation Districts

Organized programs to promote a safe and continually productive agriculture through the application of sound soil and water conservation practices are relatively new in Puerto Rico. The first erosion control and land use programs were started in a limited way in 1935. They were initiated by a Federal agency, the Puerto Rico Reconstruction Administration, as part of its general twofold objective of caring for the unemployed and stimulating economic reconstruction.

But a more permanent approach to soil and water resources problems became available when the Congress passed the Soil Conservation Act of 1935, which established the Soil Conservation Service. This agency of the United States Department of Agriculture began operating in Puerto Rico shortly after it was organized. The early activities were confined largely to carrying out

the erosion control and land use programs of the Puerto Rico Reconstruction Administration. Beginning in 1941, appropriations for the various activities of the Puerto Rico Reconstruction Administration were halted and for several years afterward the Soil Conservation Service operated in Puerto Rico with money appropriated by the Puerto Rican Government in addition to other limited Federal funds. However, it was not until 1946 that soil conservation work in Puerto Rico was placed on a solid foundation by the enactment of Law 211, designated as the Soil Conservation Districts Act.

The basic purpose of the Soil Conservation Service is to help farmers bring about physical adjustments in land use and treatment that will conserve soil and water resources, and thereby establish a permanent and balanced agriculture, reduce hazards of flood and sedimentation, and add to the general human welfare. Its field operations consist of making available, upon request, technical and certain other assistance to local conservation districts which are farmer organized and operated under laws enacted by the local legislatures. The assistance is primarily the services of trained conservationists. The districts use the technical and other assistance in helping land owners and operators plan, apply, and maintain conservation use and treatment of their land.

Law 211, enacted by the Legislature of Puerto Rico early in 1946, authorized the formation of soil conservation districts and opened to all

farmers an opportunity for democratic self-help in dealing with soil and water conservation problems of the land they own or operate. The 17 districts that were organized as a result of this legislation cover all of Puerto Rico (table 16). Each district is a legal governmental subdivision. The farmers in each district elect three persons who, with two others appointed by the Soil Conservation Committee, serve as a "Board of Supervisors" with responsibility for administering the program in the district. The Soil Conservation Committee consists of the Secretary of Agriculture of Puerto Rico as chairman, the directors of the Puerto Rican Experiment Station and the Extension Service, a representative of the Soil Conservation Service, and three farmers appointed by the Governor. It is responsible for overall administration and policy determination under the local law and cooperates closely with the district supervisors and with the Soil Conservation Service.

Each soil conservation district is empowered by the law to request the assistance of any agency, organization, or individual that may, in accordance with the type of help available, contribute in any way to the operation of the soil conservation program. So far, most of the technical assistance furnished farmers through the 17 soil conservation districts in Puerto Rico has been federally sponsored and supplied by the Soil Conservation Service. The amount of this assistance has been governed by the availability of funds appropriated

Table 16.—Soil conservation districts in Puerto Rico

District No.	Name of district	District headquarters	Municipalities included in district
1	Atlántico.....	Arecibo.....	Arecibo, Hatillo, Camuy.
2	Caonillas.....	Utuado.....	Javuya, Utuado.
3	Caribe.....	Juana Díaz.....	Villalba, Coamo, Juana Díaz, Santa Isabel.
4	Cibuco.....	Corozal.....	Toa Alta, Naranjito, Comerío, Corozal.
5	Culebrinas.....	San Sebastián.....	Lares, San Sebastián, Moca.
6	Noroeste.....	Aguadilla.....	Aguadilla, Aguada, Isabela, Quebradillas, Rincón.
7	Norte.....	Manatí.....	Barceloneta, Manatí, Ciales, Morovis, Vega Baja, Vega Alta.
8	Oeste.....	Mayagüez.....	Mayagüez, Añasco, Las Marías, Maricao.
9	San Juan.....	Río Piedras.....	Bayamón, Río Piedras, Guaynabo, Cataño, Dorado, Trujillo Alto, Toa Baja, San Juan.
10	Torrecillas.....	Barranquitas.....	Aibonito, Barranquitas, Orocovis.
11	Noreste.....	Fajardo.....	Carolina, Loíza, Río Grande, Fajardo, Luquillo, Ceiba, Vieques, Culebra.
12	Este.....	Humacao.....	Juncos, Las Piedras, Naguabo, Humacao, Yabucoa.
13	Sudeste.....	Arroyo.....	Salinas, Guayama, Arroyo, Patillas, Maunabo.
14	Suroeste.....	San German.....	Hormigueros, San German, Sabana Grande, Lajas, Guánica, Yauco, Cabo Rojo.
15	Sur.....	Ponce.....	Adjuntas, Guayanilla, Peñuelas, Ponce.
16	Turabo.....	Caguas.....	Caguas, Gurabo, San Lorenzo.
17	Torito.....	Cayey.....	Cayey, Cidra, Aguas Buenas.



A delta more than 6 feet thick at the upper end of the Patillas Reservoir has resulted from the growing of clean-cultivated crops on steep slopes upstream.

by Congress and the subsequent allocation of the money for local use.

In Puerto Rico, as in some of the States, this has resulted in far too few technically trained workers being available to meet the ever-increasing demands of the districts for help. Consequently, each year it has been possible to meet the needs of only a relatively small number of farmers who requested assistance with their soil and water conservation problems. Furthermore, the soil conservation district supervisors have failed to solicit the help they are authorized to obtain under the insular law from all other agencies and sources in Puerto Rico.

There have been other difficulties also. Many of the districts have lacked adequate local leadership capable of exercising initiative, ingenuity, and responsibility to promote cooperation and action by farmers. Much of this, of course, is due to the fact that this conservation program is rela-

tively new to Puerto Rico, and the people in the rural areas generally do not have the experience necessary to take immediate hold of such an undertaking. But all of this can be overcome. The big need in this connection is to get the people to understand and recognize what the conservation problem is in their particular area, how it affects them, and what each person can do about it. At present no such understanding that will impel widespread action prevails.

The fact that the program in the soil conservation districts is moving along at what virtually amounts to a snail's pace does not detract from the basic soundness of the program itself. It merely brings into sharp focus the need for improving and strengthening the operating mechanisms and techniques.

In order to make some of the changes that appear necessary for more effective administration, Law 211 should be amended. The present double-

headed administrative setup should be eliminated so that the conservation program may be more effectively coordinated. To accomplish the kind of unified administration that is required by the situation in Puerto Rico, it is suggested that Law 211 be amended to vest in the Secretary of Agriculture of Puerto Rico the administrative authority over appropriated funds granted to the Soil Conservation Committee by section 13, and to eliminate from section 6 the words "with the approval and authorization of the Committee." Provision should be made for an agreement with the Secretary of Agriculture of the United States so that the Director of the Federal Soil Conservation Service office in Puerto Rico may also be designated as the administrative head of the Puerto Rican Government's soil conservation work. Such an agreement between the two secretaries of agriculture would, among other things, provide for the joint administration of the Federal and Puerto Rican personnel and other resources used in the conservation program. This follows the same procedure that has operated so effectively in administering the Puerto Rican and Federal forestry programs and more recently the animal industry programs. In order to give farmers greater representation on the Soil Conservation Committee, Part A, Section 3, of Law 211 should be amended to increase to five the number of farmer members appointed by the Governor and to require all the farmer members to be named from among the duly elected soil conservation district supervisors.

Another needed amendment that should be made to Law 211 concerns the election of the Board of Supervisors for each of the soil conservation districts. The law as now written provides for each district to have a Board of Supervisors consisting of five members. Of this number, three are elected by the farmers in each district and the remaining two are appointed by the Soil Conservation Committee. The present law makes possible a substantial turnover of district supervisors every two years. A majority of new, and to some extent inexperienced, supervisors will not provide the continuity necessary to operate a successful program. To eliminate the undesirable features of the present provision, it is proposed that the law be amended to provide for the election of all five members of the Board with terms of 3 years each, except that among those first elected under such a new provision, two would be elected for a term

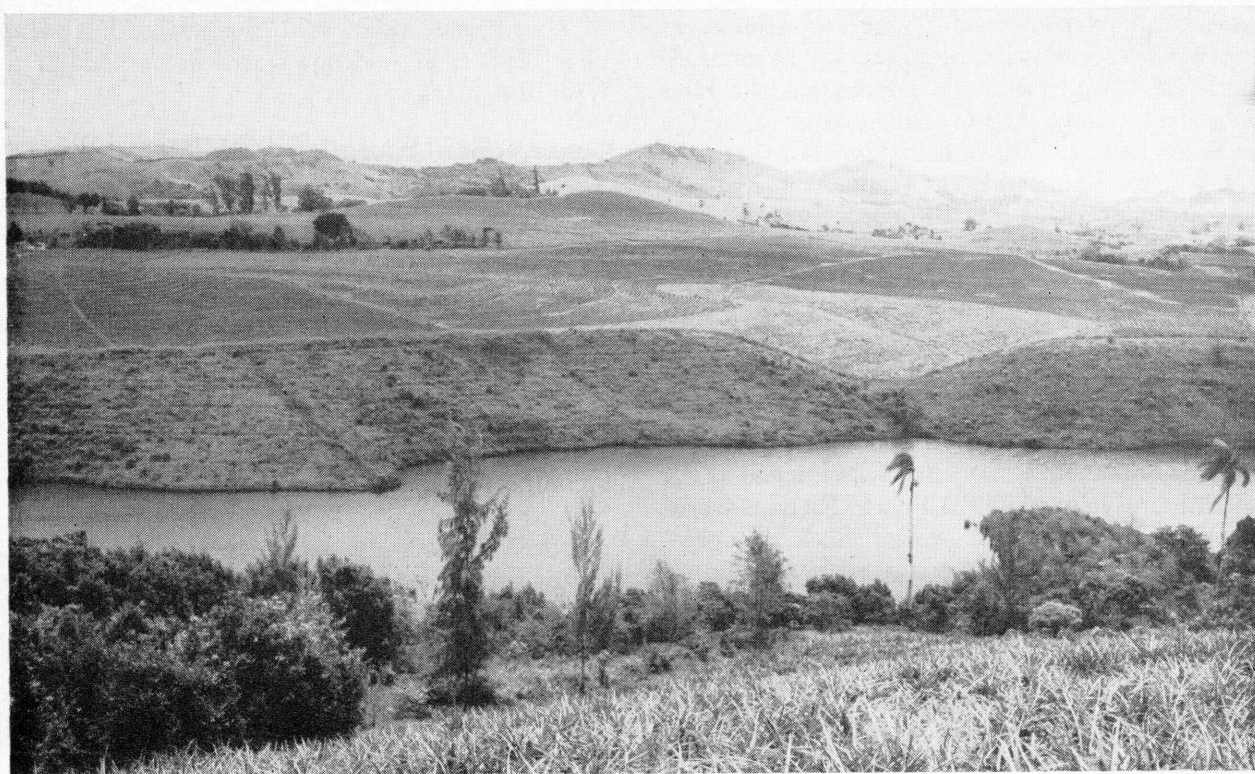
of 1 year each, two would be elected for a term of 2 years each, and one would be elected for a term of 3 years.

Conservation Education and Information

The conservation of Puerto Rico's soil and water resources, for sustained productive use, is an undertaking of vital concern to the island's people in all walks of life. The farmers have a most significant responsibility in initiating, planning, and putting into effect the various farming practices and soil treatments necessary to combat erosion and to make their lands increasingly productive. The people in the towns and cities also have an important part to play in the support they give to the concerted efforts needed to build and conserve the island's natural resources. But to arouse interest and positive action by intelligent use of rural and urban energies, it first becomes necessary to develop among all the people a full understanding of the need for conservation—what the problem is, how it affects everyone, and what each individual can do about it. This is the role of education and information.

The very measures that are needed to halt erosion and conserve soil and water generally are the same as those required for good farming. This is fortunate, for by the application of good farming practices on any of the soils in Puerto Rico production can be increased. And since a greater total output of farm products is needed, it is therefore essential that systematic and continuous efforts be made to encourage and help everyone—individuals and groups, rural and urban, private and public—to understand and join in achieving the objectives of conservation.

The various agricultural agencies, and the Extension Service in particular, must assume primary leadership in awakening the public to the consequences of continued misuse of the island's limited natural resources. The work being done must be intensified and broadened so as to develop more local leaders to help reach more people, not only in the rural sections but also in the urban areas. The 4-H Clubs and the schools where vocational agriculture is taught are contributing much to a basic understanding of conservation needs in Puerto Rico, but this should be tied in more with a community-by-community approach to the problem. This would include analysis of the extent and effects of erosion and depletion in each com-



Careful land management protects the soil and helps maintain its productivity. This view at Cidra shows sugarcane and pineapples planted on the contour with protective terraces, hillside ditches, and plantings for streambank control.

munity, the practices and measures that should be introduced to promote conservation, and the resources available locally for doing the necessary work. With such a body of information assembled in each community, the focus of attention would then be on a problem expressed in terms which the local people could readily understand.

It is relatively simple to talk about conservation and to develop plans on paper. But nothing is actually accomplished until positive action is taken to deal with the problem on the land itself. The farmer is the one who must follow through by employing the necessary good farming practices and applying the treatments needed by the land so as to conserve and make it more productive. But the actual work that the farmer does must be sparked by a desire for accomplishment. Also, the general attitude of the community can play an important part in what the farmer does. It is especially in this regard that business and professional men and women, and their service and civic clubs, can participate significantly in getting the conservation job done. In addition, those who

finance farming operations—private, quasi-public, and public credit sources—can greatly help attain conservation objectives and assure a sound basis for loans by following lending policies that favor wise land use. Moreover, encouraging conservation can be a positive and sound phase of the work of religious leaders and religious groups in both rural and urban areas.

Effective use of natural resources such as land and water can be attained only through a period of years—for some phases even decades may be required. In Puerto Rico the school system can make an admirable contribution toward shaping attitudes and developing an understanding (a) that resources are not limitless, (b) that there are practical methods for using land and water efficiently for sustained production without impairing, but even improving, their productive capacity, and (c) that the welfare of the food producer and of the urban family are definitely tied together. Such an understanding is basic to attaining and maintaining effective use of the natural resources on which the well-being of all the people so greatly depend.

Education is a slow process at best. However, its effectiveness may be enhanced by the use of properly chosen materials and techniques. The problem in Puerto Rico is made more difficult by the fact that the level of education is low, especially in the rural areas, and so many people lack any schooling. To reach these people it is necessary to rely heavily on meetings, discussions, farm tours, demonstrations, and various forms of visual aids such as exhibits, slides, and motion pictures. The ideas must be expressed in simple terms which are readily understood and appreciated by the individual.

While much is already being done in various ways, there is room for greater emphasis on certain of the methods employed and the materials used. For example, more widespread use should be made of demonstrations and farm tours so as to get farmers to learn first-hand from the actual experience of a neighbor who is in the same economic circumstances but whose cooperation has been enlisted to show what conservation farming is and how it works out. This means setting up more demonstrations on typical farms in a community and providing them with all of the help and guidance that is available to any other farmer but no more. Thus, what is done and how it is accomplished will have a practical application on other farms in the locality, and those who see such a demonstration will feel that they too can do something constructive on their farms.

Also, greater use should be made of motion pictures, slides, and film strips not only in rural sections but also in urban areas. One major need is a motion picture that would clearly depict the overall soil and water problem in Puerto Rico with emphasis on the basic causes, the damaging effects on resources and people, and what the use of conservation methods can accomplish. Such a film would be extremely helpful in getting the people to understand and appreciate what they are up against in dealing with their natural resources. Also needed are film shorts for use among farmers to show them how to do specific operations or perform certain practices in soil and water conservation.

Research Basic to Conservation

Gradually there has been developing in Puerto Rico a store of knowledge and experience which provides a sound fundamental basis for practical

soil and water conservation activities on the island. This has come about through various means ranging from accidental discovery, trial-and-error testing, to systematic research.

Since 1948, however, considerable attention has been focused on various phases of the soil and water conservation problem through research conducted by governmental agencies in Puerto Rico. This organized research work has been financed by two agencies of the United States Department of Agriculture—the Soil Conservation Service and the Bureau of Plant Industry, Soils, and Agricultural Engineering. Working in cooperation with these agencies are the Puerto Rican Experiment Station and the Federal Experiment Station in Puerto Rico, which is also a United States Department of Agriculture unit.

The results being obtained from the research activities of these agencies provide the basis for positive action in planning and applying conservation practices and treatments on the land. However, the problem in Puerto Rico is so complex that the present research activities fill only a relatively small part of the need for basic information on soil and water conservation. To meet the urgent requirements provision should be made to broaden this research work.

In general, three lines of work are being followed. One deals with the management, improvement, and evaluation of forage grasses and legumes for soil and water conservation and for plant quality and production. A second concerns evaluation of soil management and improvement practices in terms of conservation of soil and water and increased crop production.

A third involves the adaptation and application of improved irrigation, drainage, water disposal, and mechanical erosion control methods to the variable soil, climate, and topographic conditions of Puerto Rico.

While the research work carried on in Puerto Rico is producing valuable results that are being utilized in many practical ways, there still is a great lack of basic information that is essential to an effective soil and water conservation program. The wide range of climatic, topographic, and soil conditions that exist in Puerto Rico adds to the complexity of the problem and these factors combine to create a situation that has no counterpart on the mainland of the United States. There-

fore, in many respects, research on soil and water conservation problems in Puerto Rico represents a pioneering effort.

In order to meet the pressing requirements for basic information, the present research work should be extended and adequate funds should be made available for carrying on specific lines of investigation as follows:

1. Continued and intensified chemical and physical study of soils from the profile standpoint is needed. This kind of work is basic because soil is the body which produces all crops, and it must be understood, preserved, and improved, or else agricultural development becomes severely restricted. Moreover, soil and land classification are the recognized bases for conservation and production planning. A thorough understanding of soil, kept up to date with all new developments, plus slope and climatic information, is therefore an essential framework and medium on which progress in agriculture depends.

2. Soil structure deserves special attention because of its close connection with the fundamental soil physical properties. With a predominance of clay textures, as in Puerto Rico, it is recognized that proper structure is the factor which, in the long run, often sets a limit on agricultural production and land use. To the extent that it is possible to alter, evaluate, and control soil structure, a major restriction on land use and production will have been overcome.

3. Soil maintenance and improvement as related to crop sequences, utilization of crop residues, and management procedures, represent a major field of investigation which critically needs more attention in Puerto Rico. Vigorous soil-building legumes and grasses in sequences with various cultivated crops offer promise of great progress, but more of the basic facts are needed about the soil-plant interrelations, effectiveness in controlling soil loss or other deterioration, and influence on crop yields. Experimental results and observations indicate that at least the following crops are suitable for sequences with legumes and grasses: tobacco, vegetables like tomatoes, plantains, sweetpotatoes, corn, and probably sugarcane and pineapples. Erosion control measures, like bench terraces and mulching, deserve considerably more experimental attention in connection with

improved crop sequences, high crop yields, and possible adaptations of machinery.

4. Magnitudes of erosion and sources of sediment in critical inland areas, especially above valuable reservoirs, should be measured. This problem needs consideration both from the standpoint of damage to basic soil resources and damage to valuable reservoirs. On small watersheds, the erosion measurements are needed in conjunction with evaluations of the rate and amount of overland runoff as influenced by land use and control practices. On larger watersheds, from which water yields are gaged by the Water Resources Authority, more information appears to be needed about sources of damaging sediment and how to control it.

5. Erosion control structures need far more investigation. Bench terraces, slowly formed against grass barriers, need a more extensive evaluation in relation to soil, climate, and cropping systems. Small farm reservoirs need study, both as to methods of construction and proper use. Mechanical structures of all kinds in coffee plantations should be appraised. The first step should be a preliminary survey of present results from established structures.

6. Erosion control and management procedures in relation to coffee yields should be evaluated more closely. Besides the evaluation of the protective soil measures already established, it seems logical to try any other means that will help to solve the big erosion problem in Puerto Rico. Along this line the following points should be considered: (1) Careful evaluation of the chemical and physical properties of coffee soils; (2) evaluation of soil erosion control measures used in the region; (3) study of the sources of nutrient losses and soil deterioration; and (4) study of probable intercropping systems that will increase farmers' income and at the same time maintain proper conservation through a program which should include a well-planned system of trash utilization in combination with mechanical structures and a permanent soil cover, preferably a legume.

In all of the work that is undertaken, careful correlation with other investigations should be provided. For example, studies of forage crop improvement and management are an essential part of investigations concerning erosion control and soil improvement.

Chapter V

Use and Control of Water

The rains that fall on the land in Puerto Rico furnish enough water annually to power an industrial empire, yet it is not unusual for the agriculture and industry of the island to suffer from the effects of periodic drought. Instead of being conserved by sinking into the depths of the soil or by being impounded in reservoirs, most of the water is permitted to run off the land surface into unharnessed streams and rivers that empty into the sea. Thus, in an area where everything has to be stretched to the utmost simply to make ends meet, only fractional use is made of a constantly renewing potential for economic strength and human well-being. This waste is made more deplorable by the fact that, besides the land itself, water is the most valuable of the very scant natural resources in Puerto Rico.

The circulation of water from the time it falls as rain, sinks into the land, runs off to the sea, or evaporates into the atmosphere represents a rather complicated cycle. While much of what happens in this process is beyond the control of man, certain aspects can be controlled since they are influenced by factors such as the presence or absence of vegetation which may be modified by the actions of man.

In the circulatory cycle, rain water that is not evaporated or does not run off immediately into streams, is absorbed by the soil. Vegetation, through its roots, absorbs some of the ground water and in turn, through its leaves, returns much of it to the atmosphere. Other parts of the ground water reach the subsoil, which acts as a storage basin. In this way the subsoil serves as a vast underground reservoir from which, even in dry periods, the flow of streams and the water supply of wells are maintained, and thus water is

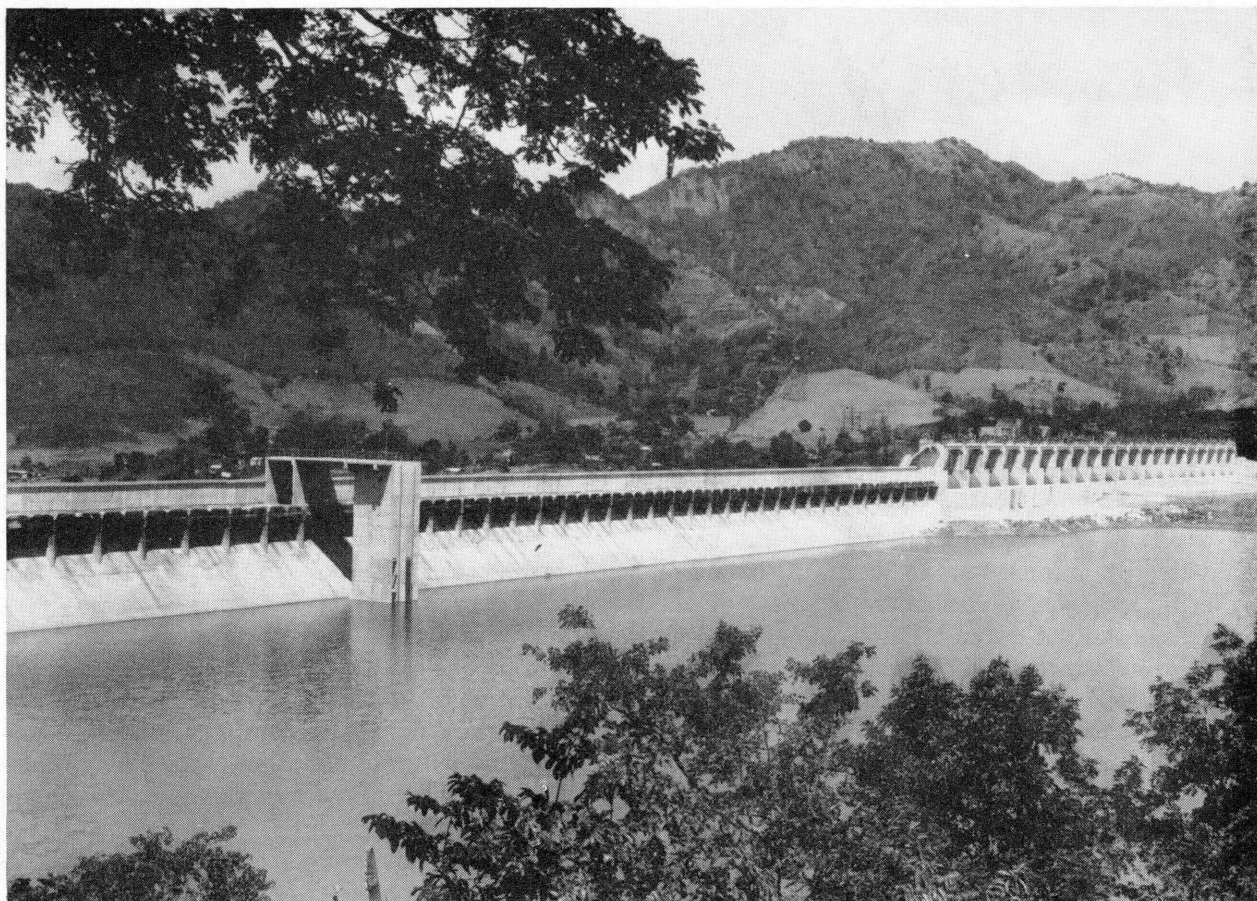
made available for domestic, agricultural, and industrial uses.

Where there is indiscriminate deforestation, overgrazing, or the growing of crops on land not suitable for cultivation, and adequate soil and moisture-conserving practices are not employed, the relationship of the various factors in the circulation process tends to be upset. Thus, water that should be slowly sinking into soils protected by a forested or grass cover, runs off instead to the streams. As this water moves over the land surface, it picks up precious topsoil which may be deposited as sediment in a reservoir downstream, or carried out into the sea.

There was a time in Puerto Rico when the water from the rains soaked into the soil and only the surplus gradually worked its way into the streams and rivers which flowed crystal clear to the sea. But that was long ago, when the island was covered by dense forests. Since then, under the pressure of a rapidly expanding population, much of this natural protective cover has given way before exploitation and reckless land use.

The great waste of natural resources that is now taking place in Puerto Rico through improper use and management seriously endangers the future of the island and the welfare of the people. Unless adequate measures are taken to halt the present trend, the productivity of the soil and the amount of land suitable for cultivation will be reduced further, and there also will be less water available for the continually increasing needs of the economy.

The future requirements for water in Puerto Rico are tied directly to the rate of population increase and the progress made in economic development. With population continuing to rise



General view of Guayabal Dam from upstream showing the bulkhead section to the left and the spillway section to the right, after the crest was raised an additional 16 feet in 1950 to restore the initial capacity of the reservoir.

at a rate that is among the highest in the world, it is already apparent that present sources of water for household uses will be inadequate within a short span of years unless they are enlarged and adequately protected. Any further development of new irrigation areas will also place an additional demand on the present limited water resources. Likewise, the present program for industrialization, with continued increases in requirements for water and electric power, will prove increasingly costly and limited unless a sound policy for the management and conservation of the island's water resources is put into effect.

The kind of water management and conservation policy that is needed in Puerto Rico involves far more than merely increasing the capacity of of reservoirs by raising the height of the dams where sedimentation already is serious, or by constructing expensive retaining walls to protect a

city from floods. Fundamentally, sound policy involves tackling each problem at the point of origin so as to overcome the cause of the trouble. Such a policy must tie in with the soil conservation program and encourage proper use and management of the land so as to reduce runoff and erosion. Furthermore, it must cover the watershed areas and protect the sources of the streams and rivers. This means giving greatly increased emphasis to the preservation of the forests, accelerating the shift of land unsuited for cultivation to other safe uses, and putting into permanent forests many of the acres formerly in forests or coffee but which are now abandoned or are being used for cultivated crops until they too must be abandoned. All of this is particularly important in the watersheds of the presently active water resources projects.

In addition, a water management and conservation policy for Puerto Rico must concern itself

with the problem of pollution, which is already serious in many respects. As population density increases and industrialization expands, this problem grows more acute and dangerous. The pollution of most streams in Puerto Rico, many of which are used for domestic purposes, constitutes a menace to public health, recreation, agricultural and industrial production, and wildlife. Corrective measures and proper controls are urgently needed to cope with this situation.

On the basis of what is now taking place, it is clear that as population rises further and industry develops there will continue to be an in-

creasing strain on Puerto Rico's water resources. The need to conserve and use these water resources wisely so they will be permanently available for the greatest benefit to the people is a challenge that must be met if the island's economy is to continue to progress.

For the purpose of bringing into sharper focus the various aspects of Puerto Rico's water resources problem, this subject is discussed in seven topics: 1, Irrigation; 2, Hydroelectric Power; 3, Domestic and Industrial Water Supply; 4, Water Pollution; 5, Flood Control; 6, Drainage; and 7, Wildlife and Recreation.

1. Irrigation

The use of water for irrigation in Puerto Rico is now confined primarily to the coastal sections of the northwestern, southwestern, and southern parts of the island. This total area, however, represents only part of the land on the island that could be irrigated profitably if the necessary installations were made. On the northern coast alone there are at least six sections where irrigation could bring into more productive use more than 50,000 acres of land. In addition to expanded use in the coastal regions, there is an opportunity for developing irrigation to supplement rainfall in much smaller areas and on individual farms in the hilly and interior sections of the island.

The irrigation systems that cover the coastal areas are publicly owned and operated, except for a very few systems that are still privately controlled by virtue of grants of water rights that date back to the Spanish Crown. The system of the South Coast Irrigation District is the largest and oldest of the publicly controlled projects. The entire district includes 51,000 acres of land of which 33,000 acres are irrigated by gravity flow of water and 18,000 by pumps and wells. The second largest public system is the Isabela Irrigation Service, which is located in the northwestern part of the island. This was developed initially to serve 18,000 acres of land, but as a result of various difficulties it now serves only about 8,300 acres. Two additional irrigation projects under construction in the southern and southwestern areas will supply more than 30,000 acres of land.

Most of the water for the public irrigation systems is supplied by eight main reservoirs (table 17). Four of these reservoirs—Patillas, Coamo, Guayabal, and Melanía—serve only irrigation needs. The remaining four—Carite, Matrullas, Guineo, and Guajataca—supply water both for irrigation and hydroelectric power.

Table 17.—Reservoirs supplying water for irrigation, 1950

Reservoir	Estimated usable water storage capacity	Average annual inflow
	<i>Acre-feet</i>	<i>Acre-feet</i>
Patillas.....	14, 000	61, 599
Coamo.....	800	23, 700
Guayabal.....	¹ 9, 799	79, 761
Melanía.....	314	3, 641
Carite ²	³ 9, 537	30, 379
Matrullas ²	³ 2, 945	15, 507
Guineo ²	³ 1, 810	7, 199
Guajataca ²	⁴ 32, 500	66, 000

¹ After crest of the dam was raised in May 1950 to restore capacity lost by sedimentation.

² Also supplies water for production of electric power.

³ Original capacity—sedimentation has been negligible.

⁴ Original capacity—sedimentation has been moderate.

The areas now under irrigation are the naturally dry sections of the island, and the water that is needed is drawn from the mountain regions. Since Puerto Rico is surrounded by tropical seas and lies well within the Torrid Zone, it enjoys abundant rainfall in the mountainous area of its interior. The rainfall, however, even though it gives rise to numerous well watered streams, is not evenly distributed over the island, varying

from about 30 inches annually along the dry southern coast to more than 100 inches in the central mountainous regions, and reaching over 180 inches in the El Yunque area in the northeastern section. This situation arises mainly from its topography and the prevailing winds.

The high mountains of the interior form a more or less continuous divide in east-west direction across the island. When the moisture laden northeasterly trade winds are deflected upward by this barrier they are rarified and thus cooled. Their moisture condenses and falls as rain, largely on the northeasterly and easterly slopes. After the winds cross the divide to the southern side, they often retain insufficient water to continue precipitation, resulting in a comparatively dry southern coast. Similarly, the northern coast, lying almost at ocean level, also receives less rain than the mountain areas. This is particularly so on the plains of the northwest corner of the island.

Present methods of applying irrigation water in Puerto Rico are in the main costly, and need to be discarded in favor of other tested methods which will make more effective use of water at a much lower cost. The land under irrigation is used mostly to grow sugarcane. Practically no other use of real significance to the economy is made of irrigation water on farms that have it available.

South Coast Irrigation District

The development of irrigation in the southern coastal region of Puerto Rico goes back into many years of history. The scanty rainfall and rather frequent failure of the water supply prevailing in that area had long been an obstacle to agricultural development. The lay of the land and the character of the soil were found to be particularly suitable for growing sugarcane, but this plant could not develop without an adequate supply of water for its growth.

It was quite natural, then, that the practice of land irrigation in this part of the island began with the early attempts to grow sugarcane. There were at first small isolated systems, some supplied by diverting by gravity the flow of streams and others by pumping from surface waters and from deep wells. By the middle of the last century water concessions for irrigation purposes began to be granted to landowners by the Crown of Spain, and in time there were many concessions.

These isolated systems, however, were inefficient since there were no impounding reservoirs, and when rainfall was deficient the water supply on which the systems depended soon became exhausted. Eventually, the idea of a general irrigation system for the area crystallized. This led to the enactment by the Legislative Assembly of Puerto Rico of the Public Irrigation Law, approved September 18, 1908, which provided the initial authority for construction of a public irrigation system in the southern coastal region.

Engineering studies for the south coast project were begun in 1908, construction was started in 1910, and the system was completed in 1914. Thus, it already has been in successful operation many years.

Essentially the irrigation system of the South Coast Irrigation District is composed of four main storage reservoirs fed with the runoff from four different watersheds, about 98 miles of main canals and distribution laterals, two generating hydroelectric plants which came into existence as a byproduct of the irrigation system, and electric transmission and distribution lines consisting of 210 miles of high- and low-tension lines.

The system is formed by three separate systems of reservoirs and canals which receive their water supply from three different sources and which bear no physical relations among themselves. These are: The system which irrigates the lands situated between the Patillas and the Salinas Rivers and which consists of the Patillas Reservoir and the Patillas Canal; the system formed by the Carite Reservoir and the Guamaní Canal which irrigates the lands located above the Patillas Canal between Guayama and Salinas; and the system originally formed by the Toro Negro Diversion, Guayabal Reservoir, Coamo Reservoir, and the Juana Díaz Canal. This latter canal runs in an easterly direction from Juana Díaz toward Salinas and irrigates all the lands lying between the Jacaguas River and the Río Jueyes near Salinas. The irrigation system of which it is a part was enlarged with the addition of the Guineo and the Matrullas Reservoirs in 1931 and 1934 respectively. Each of these three systems functions independently, that is, the irrigation waters, with the exception of the minor relation existing between the Guamaní Canal and the Melanía Reservoir, do not meet at any place but flow through separate canals

located at different elevations and irrigate separate sections of the district.

The total acreage under irrigation in this south coast project amounts to approximately 51,000 acres, of which 33,000 acres receive water by gravity from the irrigation system and 18,000 are irrigated by pumps supplied from deep wells and operated with electricity served from the hydroelectric system. Of the 33,000 acres irrigated from the irrigation system, 12,800 acres receive water from the Patillas Canal. The Guamaní Canal serves 4,950 acres, and the Juana Díaz Canal takes care of 15,250 acres.

The amount of irrigation water fixed by the Public Irrigation Law as appurtenant to the land is 4 acre-feet per acre per year, which is equivalent to an application of about 4 inches of water each month to the land under irrigation. This is the amount that was estimated as necessary to supply the deficiency in the rainfall on the south coast.

The south coast system has been delivering water at this rate of 4 acre-feet per year to each acre of land uniformly throughout the year. The methods and the sequence followed in the cultivation of sugarcane in this district require that irrigation be practiced continuously (not merely during certain seasons as in some other areas). Accordingly, the project was planned and carried out subject to the requirement that it would have to function continuously and uniformly.

To enable the planters to use the water to best advantage, each planter is allowed to group and use all the water to which he is entitled, as appurtenant to all the land under his control under each of the three systems of canals, and to deliver this water in the amounts and through the outlets requested. This method of delivery, authorized by the Public Irrigation Law, permits the water to be applied to the fields economically. The planters are able to keep their labor costs down and also get the greatest benefit out of the water since they can apply it by rotation to their various tracts of land, using the water in quantities and in the number of times during the month best suited to their needs.

The irrigation service measures and delivers the water to the planters through outlets which have been located so as to irrigate by gravity all of the land served by those outlets. Each outlet consists of a gate and an orifice plate arranged as to space

and elevation so as to obtain an accurate measure and an uninterrupted flow of water into the field ditches prepared by the planters. The quantity of water delivered each month is one-twelfth of the amount appurtenant for the year. When owing to shortage in the water supply it becomes impractical to deliver the full amount appurtenant for the month, then the planters are allowed a time extension of 11 months within which the shortage will be delivered to them, provided the supply becoming available is sufficient to cover first the regular monthly deliveries and then the shortage.

In the case of lands which are receiving water from the irrigation systems under unrelinquished water concessions which were granted prior to the establishment of the system, water deliveries are made continuously even though there may be a shortage in the reservoirs. In other words, deliveries to such concession lands are not subject to a reduction proportionate to the supply available as is the case with deliveries to other lands included in the irrigation district.

When the supply available in storage is larger than is required to make full deliveries to the lands included in the irrigation district, then this surplus water is sold to the planters who request it at a price which is fixed for each fiscal year at an amount approximately equal to, but never less than, one-fourth of the water tax for the year.

The quantity of 4 acre-feet per acre per year has proved sufficient for a good part of the land included in the irrigation district, but for porous sandy soils, which abound in this zone, it falls short of meeting the irrigation requirement. To supply the deficiency, the planters avail themselves of underground water which they bring to the surface by means of tubular wells and pumps. This source of supply is being constantly replenished by the same irrigation water furnished by the gravity system which is applied to the surface, a great part of which percolates into the lower strata.

A large number of pumping installations are scattered over this south coast area and, with rare exceptions, they are all driven by electric motors. For this purpose electric power service at a low rate is needed and the hydroelectric system, which came into existence as a byproduct of the irrigation system, has been progressively developed to meet this need.



Typical of the installations that pump irrigation water is the Providencia Pump near Salinas.

Considering the widespread use of pumps to make available the quantity of water used in the irrigation of those lands which require more water than the gravity system can supply, as well as for increasing the area under cultivation, the South Coast Irrigation System may well be classified as a combined gravity and pumping system. The Puerto Rican Government has centered its activities on building of the gravity system and supplying at low rates the electric power required to operate the pumps, but it has left to private initiative the exploration of the underground water supply as well as the investment of capital required for the pumping installations.

The income necessary to operate the south coast irrigation project is provided by (a) revenues from the sale of electric power, (b) receipts from incidental sales of surplus water, and (c) assessment on the lands included in the irrigation district of a tax sufficient to raise the required remainder.

The total irrigation revenues during fiscal year 1949-50 amounted to \$390,840 while the sales of electric power in the district alone accounted for an income of \$922,954.

The expansion of the hydroelectric system of the South Coast Irrigation Service has been such that it plays a role of major importance as a source of revenue as compared with what the water tax contributes to the running expenses of the service. The revenues from the sale of electric power have constantly increased every year from about \$25,000 in 1916-17, which was the first full year of operation of the Carite Hydroelectric

Plant No. 1, to amounts which now average more than \$900,000 a year.

Of the 33,000 acres of land irrigated by gravity from the irrigation system, approximately 24,000 acres pay the regular water tax, and 9,000 acres, which were formerly irrigated from old concessions, are exempted from the payment of the irrigation tax but are assessed and pay each year a small tax to cover their share of the cost of operation and maintenance of the system.

The amount of the regular water tax remained at the maximum of \$15 per acre per year authorized by the Irrigation Law from 1914 until 1922. From that year until fiscal year 1935-36 it decreased gradually to \$7.17 per acre, mainly because of the large increase in the income from the electric power business. Since 1940 the tax has increased gradually with rising costs of labor and materials. However, during recent years, partly on account of the limitation of \$15 per acre per year fixed by law, the irrigation system has been forced to work on a restricted budget, delaying needed maintenance to balance the budget.

The average yearly crop from land now in the South Coast Irrigation District during the 7 years from 1909 to 1915, that is, just previous to the operation of the irrigation system, was approximately 54,000 tons of sugar. The crop for the 5 years 1945-50 averaged more than 200,000 tons of sugar. This increase in annual yield is not, of course, wholly attributable to irrigation since improvement in cane varieties has been a very great factor. But such an increase would not have been possible without irrigation. This increase of some 150,000 tons of sugar in the irrigation district represents a gain of more than \$15,000,000 in the value of the crop produced each year.

Isabela Irrigation Service

The Isabela Irrigation Service was originally established to supply water for irrigating a projected area of 18,000 acres of land distributed among the municipalities of Isabela, Aguadilla, and Moca.

Water for irrigation is obtained from the Guajataca River, which is impounded in the Guajataca Reservoir located 6.2 miles south of the town of Quebradillas. The capacity of the reservoir is 32,500 acre-feet. The annual runoff of the river ranges from 53,000 to 79,000 acre-feet. The diver-

sion canal follows along the canyon of the river from its heading at the reservoir for a distance of 3.1 miles and then northwest for 1.2 miles to the irrigable lands. This canal ends at an elevation 105 feet above part of the irrigable lands, and at this point there is installed hydroelectric Plant No. 1.

The main arteries of the irrigation district are the Main Canal 5.5 miles long, Moca Canal 13.4 miles long, the Aguadilla Canal 6.2 miles long, and 109.7 miles of water distribution laterals.

This service was started about 1928, and after many modifications and revisions of the irrigation district, the area under irrigation has been reduced until now it is down to about 8,300 acres from the original 18,000 acres. A significant feature of the area is the large number of small farms that are included in the permanent irrigation district (table 18).

Table 18.—Farm units in Isabela Irrigation District

Size of farm	Tracts	Total area
<i>Acres</i>	<i>Number</i>	<i>Acres</i>
Less than 1.....	70	34. 50
From 1 to 2.....	150	232. 54
From 2 to 5.....	247	839. 45
From 5 to 10.....	149	1, 051. 09
From 10 to 20.....	95	1, 300. 41
From 20 to 30.....	28	693. 79
From 30 to 50.....	16	639. 97
From 50 to 100.....	9	617. 63
Over 100.....	15	2, 947. 02
Total.....	779	8, 256. 38

The agricultural lands in the Isabela area are largely devoted to the cultivation of sugarcane, which utilizes 6,400 acres. The rest of the farm land is generally planted to cotton, corn, tobacco, peppers, and other vegetable crops. According to the yearly crop census made by the personnel of the Isabela service, only half of the acreage planted is actually irrigated. Most of the irrigation water is applied to sugarcane, and very few farmers use irrigation for any other crops in the area.

The failure of farmers to make full use of the irrigation system apparently stems more from a lack of interest than from the cost of the water that would be used. Irrigation assessments are at the rate of \$1 per acre per year without allotment for the first 10 acres included. For all acres in excess of the first 10 included, the rate is \$4

per acre per year, which includes \$1 as a charge for readiness to serve and \$3 as the value of 1½ acre-feet allotments per year. Water may be sold to proprietors who have paid their assessment at the rate of \$2 per acre-foot included, and at \$2.50 per acre-foot to those who owe for two or less 6-month periods.

Water is also supplied by the Isabela Irrigation Service to the aqueducts and sewage systems of Aguadilla, Isabela, Moca, Aguada, Quebradillas, and Ramey Field. The water served annually for these purposes totals approximately 3,500 acre-feet.

The biggest source of income, however, is from the sale of hydroelectric power. This amounts to more than \$400,000 annually, which is roughly 12 times the income obtained from irrigation taxes and the sale of water.

Financing the operation of the Isabela Irrigation Service has been a continuing problem from the start. The system was established at a cost of more than \$4,000,000 to irrigate the projected area of 18,000 acres. But since the area included in the permanent system has been reduced to 8,300 acres, with only half of this acreage actually irrigated by farmers, the cost factor became an obvious burden. After several years of operation, it was found necessary to obtain additional revenue and this was done through an expansion of hydroelectric power. At the time, it offered the best solution to the problem of getting the steady and rising yearly income needed to defray operating expenses and to help pay the initial high cost of the installation. Unfortunately, however, the course chosen does not favor interest in expanding or trying to foster the efficient use of a maximum quantity of water for irrigation.

For several years most of the landowners in the irrigation district were heavily in debt, as a result of unpaid water taxes and yearly increases in rates of taxation. The Puerto Rican Legislature, however, passed numerous laws canceling these debts and reducing to a minimum the irrigation taxes as well as the payment for water served. Even with these reductions, no marked increase has taken place in the use of irrigation by individual farmers.

Additional Areas for Irrigation

The productivity of many thousands of acres of agricultural land in Puerto Rico could be in-

creased materially by making available additional supplies of irrigation water. Plans have already been made for bringing irrigation water to two areas, but other areas should also receive attention.

Already under construction is the Southwestern Puerto Rico Project which proposes a complete development for the area of the Lajas Valley. This would include: (1) Reclamation and preservation of 26,000 acres in the southwestern part of the island most of which are among the best agricultural lands in Puerto Rico, (2) creation of a good potable water supply for the towns of the region, (3) production of 100 million kilowatt-hours of hydroelectric energy, and (4) protection of property from floods in the Yauco, Añasco, and Susua River Basins.

Also planned is the Coamo-Bauta Project which proposes irrigation by gravity of some 4,800 acres of land in the Coamo region of the island and the development of 14,900 kilowatt-hours of hydroelectric energy.

Along the northern coast there are six areas which deserve special study as possibilities for the development of irrigation. These are: (1) The Arecibo River coastal area, (2) the Manatí River coastal area, (3) the La Plata River coastal area, (4) the Cibuco River coastal area, (5) the Loíza River coastal area, and (6) the Espíritu Santo coastal area.

The Arecibo River is controlled at the Dos Bocas and Caonillas Dams, which have a combined capacity of nearly 70,000 acre-feet providing a well regulated flow capable of irrigating some 25,000 acres of land in the lower basin.

There is no storage development in the Manatí River Basin but this river has a minimum unregulated flow capable of irrigating some 8,000 acres of land in the lower basin. The Water Resources Authority is studying a hydroelectric development on this river which may provide future storage facilities for the irrigation of more than 20,000 acres of land in this area.

There is no adequate regulation of the waters of the La Plata River flowing to the north coast since the Comerío Reservoir is almost full of sediment. Nevertheless the minimum flow of this river would irrigate some 8,000 acres in the lower basin area. The Comerío Extension Project, a possible future hydroelectric development, may provide the necessary storage facilities to increase

substantially the possible acreage of irrigated lands in this area.

The unregulated waters of the Cibuco River are capable of irrigating more than 3,000 acres of land in its lower basin area. No promising site for hydroelectric development has been found in this river basin.

The Loíza is the best watered river on the island. The Puerto Rico Aqueduct and Sewer Authority is at present constructing a dam on this river which will provide storage facilities for water needed by the metropolitan area of San Juan and also for the production of hydroelectric power. The regulated outflow from the hydroelectric plant will be returned to the stream below the impounding reservoir and will be available for irrigating lands in the lower basin.

The El Yunque Project proposes to utilize the water of the Espíritu Santo and other streams on the north side of the El Yunque area and would provide, when constructed, storage facilities for the regulation of some 50 cubic feet a second of surface waters from this area. These waters could be used to irrigate some 5,000 acres of land to the north of the town of Río Grande.

Most of the water from these and other unharmed streams is being wasted at present. The total quantity of surface water in cyclic circulation on Puerto Rico, measured in precipitation, amounts to about 36,000 acre-feet daily. This is roughly 30 times the average flow of the Loíza River. Some 18,000 acre-feet per day, on the average, return to the atmosphere as vapor through evaporation and transpiration, leaving a remainder of some 18,000 acre-feet a day which represents the surface waters draining to the sea.

The tremendous energy carried by the streams of Puerto Rico may be visualized if it is realized that the 9,000 cubic feet per second average surface flow of the island's streams falling 1,000 feet does the work of some 900,000 horsepower, night and day, all the time. This amounts to an average yearly production of hydroelectric energy of some 5,600 million kilowatt-hours, which is about 23 times the actual production obtained now on the island from this source. The annual surface flow would cover 1,000,000 acres of land to a depth of about 80 inches. A substantial part of this large supply of surface water is now wasted to the sea, especially through streams flowing to the north coast of the island. This loss could be reduced

with great benefit to the agriculture and the general economy of the island by establishing wherever feasible projects that would utilize the water for irrigation and the production of hydroelectric power.

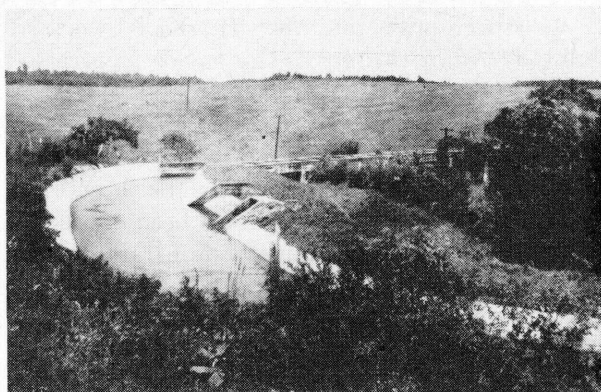
Overall Problems in Water Management

Use and conservation must go hand in hand in the overall management of water resources. Although the manner of use is important from the standpoint of the economic benefits to be derived, proper conservation is necessary to insure prolonged use. For example, where a dam is built to impound water, the life span of the reservoir is largely dependent on how much sedimentation takes place from the waters that run into it for storage.

In considering the problems associated with sedimentation of reservoirs and the resulting damage, the fact stands out that the movement of a certain quantity of soil and rock particles by running water from higher to lower parts of a stream drainage area is a natural and continuous phenomenon that cannot be stopped by man. In planning and designing reservoirs in Puerto Rico, and in all other parts of the world, this basic fact is recognized and is included in estimating the economic feasibility and the life span of projects. But, even when the quantity of sediment transported by a stream does not prove to be a critical factor, interest in the rate of erosion should not diminish. By reducing erosion, a low rate of silting may be maintained so as to prolong the useful life of storage reservoirs many years after the cost of their construction has been amortized. Since desirable sites for storage reservoirs are extremely limited in Puerto Rico, this factor alone demands that they be made to serve as long as is practically possible.

The silting of storage reservoirs in Puerto Rico has specially significant objectionable results because of the seasonal distribution of rainfall, which necessitates ample storage to conserve runoff during the wet season for use during the dry season. Most of the water stored in reservoirs on the island is used for the development of power, irrigation, and domestic and industrial water supply, all requiring continuous delivery.

The value of a dam depends, in varying degrees, on the amount of reservoir storage the dam creates. Dams on larger rivers that have relatively uniform



The Juana Díaz Canal brings irrigation water to more than 15,000 acres of farmland along the south coast of Puerto Rico.

flow may create little or no storage (although usually some pondage) value. On the other hand, dams on streams of variable flow may be valued in large measure by their creation of storage capacity for equalizing the flow.

Variable stream flow is the rule in Puerto Rico, and accelerated sedimentation of reservoirs results in the loss of power, irrigation, and other water use values that, under a lower rate of sedimentation, would be available for a longer period.

Efficiency in the use of water is an important phase of water resources management. Irrigation is costly in Puerto Rico because of the large amount of labor required by the prevailing methods of water distribution. The cost of the water itself to farmers is reasonable where supplied by the Government, but water from some private developments is much more costly.

The loss of water through inefficient methods of application adds greatly to the overall cost. As an average, approximately 70 cents out of every dollar paid for water is lost because the water leaches away. With improved methods only 25 percent or less would be lost in this way. If all irrigation water was distributed efficiently, there might be no lack of water for maximum yields on land now under irrigation. Moreover, certain adjoining lands which are not now irrigated could receive water they need.

A continuing problem in the Isabela irrigation district, for example, is the great loss of water that takes place through seepage and other causes. When the irrigation system started operation, it was found that from 50 to 60 percent of the water was lost through seepage and occasional sink holes that appeared in the main irrigation canals and

in the distribution laterals. In the network of canals owned by the service this has been corrected by lining the canals with concrete. The losses of water through cracks and other causes in the diversion canal have now been reduced to 4.6 percent. The losses in the Moca Canal, which has been lined with precast concrete slabs, have been cut down to 20 percent. This latter method of lining canals does not appear satisfactory since there always will be numerous cracks between the slabs where water may escape in considerable quantities. The losses of the main canal have been reduced to 12 percent. This main canal and several other important laterals have been lined with concrete, using a mixture of cement, sand, and *polvillo* from local stone quarries.

In spite of all these improvements that have been made to save water, the overall losses through seepage, cracks, evaporation and other causes are still considerable. In 1949-50 they amounted to 29.2 percent. The water losses suffered by the farmers are above 50 percent.

Water applied in excess of needs is not only lost, it also leaches away needed plant nutrients, especially nitrogen. This increases fertilizer costs and reduces yields per acre.

If all of the land in Puerto Rico received adequate water at all times it is estimated that total agricultural production would be increased by one-third or more, but very little effort has been made by the Puerto Rican Government to demonstrate to farmers the benefits from irrigation under normal weather conditions and under dry conditions. With the exception of a single irrigation experiment performed with sugarcane, no research has so far been carried out with other crops to indicate the influence of irrigation water in increasing yields.

Observations made at Aguirre *Central* show sugarcane can utilize from 100 to 160 inches of water a year, including water lost by deep percolation during irrigation. The amount of such loss depends on the soil properties, porous sandy soils needing the most water and clayey soils needing the least. Rainfall on the lands where these experiments were conducted averages about 45 inches a year. These lands receive the equivalent of some 45 inches more of rainfall from the South Coast Irrigation Service. This total of 90 inches has been found inadequate and is profitably supple-

mented by more than 50 inches of water obtained by pumping from the subsoil.

Rainfall in the north coast area averages from 60 to 80 inches per year. This is less than the amount of water received from rainfall and gravity irrigation by Aguirre *Central* lands, with the further inconvenience that rainfall water is unevenly distributed during the year while irrigation water can be served when it is most needed.

During years of normal rainfall, supplemental irrigation on the north coast lands may not show a particularly high gain in yield over nonirrigated lands. However, irrigation presents an insurance against damage to crops as a result of possible dry spells, prolonged or short, which could readily cause millions of dollars in losses. Viewed in this way, the margin of profit from irrigation is high compared to the cost. The fact that the north coast area is favored with an adequate supply of surface water which is now wasted to the sea, adds to the attractiveness of supplemental irrigation for this area.

Approximately 100,000 acres are now under irrigation in Puerto Rico. This represents about 10 percent of the total cultivated acreage. At least 90 percent of the irrigated land is used for growing sugarcane. A very small acreage is irrigated by sprinkling, the remainder by furrow methods. The so-called "McLane" system with minor variation is used on an estimated 90 percent of the irrigated area. This is a short furrow, or essentially a modified basin method. Each furrow is filled individually from closely spaced supply ditches, or "McLanes," which most commonly are spaced from 20 to 40 feet apart. Recently, some "McLanes" have been spaced as much as 72 feet apart. Long furrows are graded for about 0.5 percent of fall, and the shorter furrows are often level. In essentially all systems, sugarcane is planted and grows in the bottom of the furrow. With time and cultivation the furrow tends to fill so that during the second or later years, the capacity for water is much reduced. The canes also retard and interfere with water movement in the furrows.

On the lands of Luce & Co. in the Santa Isabel area, numerous tests have been conducted to determine the efficiency of various methods for applying irrigation water. These have shown that,

on the average, about 40 percent of the water applied is held in the root zone for plant use. Highest losses occur when the land is poorly prepared, and when excess quantities of water are applied at times when the soil has only a small capacity to store available water. More limited tests have been made throughout other parts of the island.

As an overall average, it is estimated that only 30 percent of the water applied as irrigation is held in the soil for plant use. In certain cases only 20 percent is retained, 80 percent being lost by deep percolation or by runoff to the sea. From this it is apparent that any considerable improvement in the efficiency of applying water would obviously result in a substantial saving of water. Also, the prevailing methods of furrow irrigation have a high labor requirement, making distribution more costly. The average irrigator probably irrigates about one acre per day. Careful planning, training, and supervision have increased the acreage per man-day to two acres and more in some cases.

Properly designed sprinkler irrigation is an efficient method of water application. Repeated determinations in cooperation with Luce & Co. have indicated that with properly spaced appli-

cations of about one inch per irrigation, an average of 75 percent of the water is held in the root zone. Most of the remainder probably blows away as spray or is evaporated. Sprinkling also has a low labor requirement. But the initial costs of equipment and the upkeep tend to be high, although these costs are being reduced as various improvements are made. The feasibility of widespread sprinkler irrigation appears to be primarily an economic problem for which there is as yet no stock answer. Its efficiency in saving water and labor is unquestioned. On the other hand carefully laid out and properly used furrows can provide at least 50 percent efficiency; average practices with planted cane are about 40 percent efficient; poor practices which are common through Puerto Rico give only 25 percent or less efficiency in the distribution of water.

Once the advantages of surface irrigation and the greater advantages of overhead irrigation are more widely known throughout the island, it should be possible to overcome the apathy toward irrigation that now exists among many farmers. This would, perhaps, lead farmers to organize cooperative or government-sponsored portable sprinkler systems.



A field of green peppers at Isabela being irrigated by a sprinkler system. The use of overhead irrigation is relatively new in Puerto Rico.

The need to educate farmers to the value of irrigation and the methods to be employed for effective results is not confined to any one area. Most of the farmers in Puerto Rico think of irrigation in terms of irrigating sugarcane. The general tendency is to overlook the possibilities of irrigating other crops profitably. Few other crops are irrigated on a substantial scale, even though irrigation water may be available.

One of the drawbacks has been the lack of information concerning the irrigation of crops other than sugarcane. Experimental work is needed to demonstrate the value and methods of irrigating a wide range of crops under the different conditions found in the various parts of Puerto Rico. These crops include cotton, pineapple, vegetables, grain, and hay and pastures. The possibility of irrigating coffee trees during critical periods when the crop is forming so as to supplement rainfall might also be worth exploring, especially where the land is not too steep.

Several large areas suitable for irrigation are dependent upon the development of new water supplies. The Lajas Valley and the Coamo area are two of these, and the irrigation projects being developed for them will tap distant sources of water supply. The information already obtained relative to the efficient use of water and irrigation practices in the Santa Isabel-Aguirre section are generally applicable to these new areas.

Many areas with little or no irrigation at present would profit from supplemental irrigation if water supplies were available. Practically all of the island suffers from dry periods at some time during the year. The Mayagüez area in particular is badly in need of supplemental water during a period of from 4 to 6 months almost every year. If local or reserve water supplies could be developed for supplemental irrigation when and where needed, a great number of the farms on the island would benefit materially. Production would be increased considerably, especially if growers were educated to the fact that irrigation is profitable for many other crops in addition to sugarcane.

Focal Points for Action

In considering the irrigation needs of Puerto Rico, it must be recognized that despite many shortcomings the island has made notable progress in the use of water irrigation. The island has had

very little outside help and most of what has been accomplished in developing the various projects in the last half century has been through local governmental effort and enterprise. Irrigation has contributed greatly to agricultural productivity and has made it possible to bring into use lands which otherwise would remain far less productive. This has been of vital importance to the economy, and it can become far more significant for the future.

The experience that has been gained—both good and bad—offers a sound basis on which further development of irrigation in Puerto Rico may advance, provided full advantage is taken of the lessons taught by experience with existing projects. The fact that a large part of the water resources of Puerto Rico are still unused and are being wasted when the economy could profit so greatly if they were fully and wisely employed, stands out as a prime motivating force for prompt and determined action.

But action cannot effectively accomplish a set purpose without organized planning and follow-through, adequate education and information, and research sufficient to provide the basis for the work that is scheduled. The one main weakness in the development and operation of irrigation projects in Puerto Rico is that various agencies in position to help either have not been fully utilized or else they have not been directly tied in with the work soon enough. Projects for irrigation (or for any other purpose involving the broad interest of agriculture) should be considered and planned jointly by all agencies concerned. In this way the single agency charged with the basic responsibility will have the benefit of technical assistance and advice which will enable it to avoid or anticipate possible pitfalls. At the same time, the participating agencies will be in position to evaluate the needs they may have to meet in servicing the project and to prepare in advance for meeting the load when the project is completed. This sort of teamwork and cooperation can contribute much to insure the successful operation of any project that serves a community. This is a problem that demands constant attention so that the healthy relationships basic to good teamwork may be fostered and responsibilities to the public recognized and discharged without stint.

The different agricultural agencies concerned with research, education, and operational programs could help solve many of the difficulties if their technical resources were focused on them. Although a great deal of information is available about the use and control of water for irrigation and other purposes, there is much that remains to be developed to meet the special conditions of soil and other factors found in Puerto Rico.

For example, there is a need to determine the economical methods and the cost of improving present irrigation canals and laterals in order to reduce water losses to a practical minimum. Once this has been determined, it should provide the basis for making funds available for the necessary improvements. At the same time, provision should be made for furnishing to farmers the technical and other assistance that will be required to enable them to cooperate in this work.

Also, there is an urgent need to encourage farmers to improve efficiency in their use of irrigation water. This could be accomplished through educational activities, demonstrations, and suitable information, but certain incentives may also be required. Perhaps a system of rate differentials might be employed as an incentive that would favor water users who make and maintain certain approved permanent improvements. Consideration should also be given to the possibility of making incentive payments on a soil conservation basis for lining with concrete irrigation laterals and ditches running through individual farms. Some form of incentive may be desirable to encourage farmers to construct watertight irrigation reservoirs on their farms.

A well planned research and educational program directed at the water supply and utilization problems would fill a big gap in the present situation. With the possible exception of the individual investigations carried out by some of the sugar *centrals* in Puerto Rico, research and education on the use and conservation of water have been rather limited. During the last 2 years some valuable information on conditions along the south coast has been obtained through research work by the Soil Conservation Service and the Bureau of Plant Industry, Soils, and Agricultural Engineering of the United States Department of Agriculture, cooperating with the Puerto Rican Experiment Station. These results clearly indicate the

need to develop additional information not only for the south coast but also for other sections.

In moving forward with such a program, closer and more direct technical linkage should be established among the various agencies such as the Extension Service, Puerto Rican and Federal Soil Conservation and Forest Services, Water Resources Authority, Production and Marketing Administration of the United States Department of Agriculture, Experiment Station, and any other agencies or groups which may be concerned with water use and conservation. Direct liaison and close cooperation among all agencies are essential to insure that fundamental information obtained through research is promptly put to practical use.

There is an immediate need for a wide range of experimental and research work to produce the information required for use in overcoming existing problems as well as for making improvements in irrigation on the island. Early attention should be given to the following:

New methods of furrow irrigation should be devised and adapted to local conditions and their efficiency tested in terms of water held in the root zone as well as in terms of crop yields.

More information is required concerning the plant use of water under irrigated conditions by important crops other than sugarcane, by sugarcane at higher levels of production that result from increased fertilization and other improved practices, and by fall-planted (*gran cultura*) crops of sugarcane.

Determination should be made of the use of water by upland crops in areas not now irrigated, in relation to weather, soil moisture, and runoff from small watersheds. Such information would be very helpful in measures taken to increase crop production, in calculating total water supplies, and in developing soil and water conservation practices, and in designing conservation structures. For the northern and western sections especially, sprinkler irrigation as compared with furrow methods should be more accurately evaluated, in terms of water savings, yields of various crops, and costs to irrigate.

The need for supplemental irrigation should be determined for areas where rainfall is considered adequate during most of the year. Also, work should be done in these areas to find out whether crop adjustments and small reservoirs or other

devices could be used to increase the total per acre crop returns.

The relation of evaporation and transpiration to weather should be developed in more detail. Additional information about the influence of hours and intensity of sunshine and wind is especially needed. Also, the effect of windbarriers or windbreaks on evaporation and transpiration should be investigated.

There is a need for determining the benefits to be derived from irrigation of farms located in the agricultural areas of the six north coast rivers. This is necessary before any development project is undertaken.

Work should be done to find out what are the best methods of land preparation and irrigation ditching, of lining secondary canals with concrete, and of flume and reservoir construction. The proper spacing and depth of open ditches and the

possibilities of tile and mole drainage systems should also be explored.

Research relating to water movement in soils and physical properties of soils should be intensified. Also, research is needed to determine the possibilities of increasing the capacity and efficiency of underground storage of water which is now being lost to the sea. This should include consideration of the possibilities of water spreading and other devices as a means of increasing the input into appropriated underground reservoirs.

In all of the work that is carried on there must be, of course, a constant alertness to changing conditions and new developments that may be adapted to local requirements. This means keeping abreast of findings in such activities as the removal of salts from sea water and even artificial rain making as well as many others that are more prosaic.

2. Hydroelectric Power

The development of the public electric power system in Puerto Rico was an outgrowth of the public irrigation system that was initiated in 1908 when construction of the Patillas, Carite, Coamo, and Guayabal Reservoirs got under way.

In 1915 the Carite Hydroelectric Plant No. 1, the first waterpower development of the public system, was placed in operation by the Puerto Rico Irrigation Service with a generating capacity of 700 kv.-a. (kilovolt-amperes). Additional units were installed at Carite Plant No. 1 in 1924 and 1931 and a second plant, Carite No. 2, was built in 1922 below Plant No. 1. These plants had a combined rated capacity of 5,000 kv.-a.

Encouraged by the success of the Carite system, the Puerto Rican Legislature in 1925 passed an act creating the agency known as the Utilization of the Water Resources for the purpose of promoting the development of industry and the supply of electric power to rural areas. Under the authority of this act, the Toro Negro system was begun with the construction of Toro Negro Plant No. 1, located near Villalba, having an initial installed capacity of 5,400 kv.-a. Additions were made to Plant No. 1, and Plant No. 2 was built in 1935, bringing the rated capacity of the Toro Negro system to 13,200 kv.-a. Carite Plant No. 3

was started in 1935 and finished in 1937. It added 800 kv.-a. to the system operated by the Utilization of the Water Resources (Carite No. 1, and No. 2 were still operated by the Puerto Rico Irrigation Service).

Hydroelectric plants next added to the system were the Salto Garzas No. 1 (9,000 kv.-a.), Salto Garzas No. 2 (6,300 kv.-a.), and Dos Bocas (22,500 kv.-a.). Their construction was started in 1937 as projects of the Rural Electrification Division of the Puerto Rico Reconstruction Administration, but the plants were completed by the Puerto Rico Water Resources Authority in 1943. In 1941 the small hydroelectric plant of the city of Arecibo (900 kv.-a.) was added to the system by means of a lease contract with a long-term purchase option.

In 1941 the Puerto Rico Water Resources Authority Act was passed and later amended in 1942. The Board of Directors of the Authority, which now consists of the Governor of Puerto Rico, the Secretary of Public Works, and the Secretary of Agriculture of Puerto Rico, was given broad powers, including the right to make contracts, to acquire property, and to use, transmit, distribute, sell, rent, or otherwise dispose of water, electric energy, equipment, supplies, and services.

Under the powers of this act the Water Resources Authority purchased the property of the Puerto Rico Railway, Light & Power Co. and the property of the Mayagüez Light, Power & Ice Co. in July 1942.

Acquired with the Mayagüez system was the Mayagüez Steam Plant, which had been operating since 1930 with a capacity of 5,000 kv.-a. The San Juan system comprised three power generating developments with a total rated capacity of 34,125 kv.-a. These developments were the following: Comerío Hydroelectric Plant No. 1, completed in 1907, with a capacity of 2,000 kv.-a.; Comerío Hydroelectric Plant No. 2, completed in 1913, with a capacity of 4,000 kv.-a.; Río Blanco Hydroelectric Plant, completed in 1930, with a capacity of 6,250 kv.-a.; and Santurce Steam Plant, which has operated since about 1910 and in 1942 had a capacity of 21,875 kv.-a. Thus, the generating capacity of the Water Resources Authority system was increased by 39,125 kv.-a. with these acquisitions.

Work on new electric power developments was hampered by the shortage of manpower, materials, and equipment due to World War II, and construction lagged behind the growth in demand for electric energy. In addition to the power generated in its own plants, the Water Resources Authority bought the surplus energy available at the private plants of various sugar mills and from the Navy-owned Ceiba Naval Base Steam-electric Station (10,000 kv.-a.) at Roosevelt Roads, the latter plant being subsequently leased by the Authority as of June 1, 1946.

A new turbo-generator unit (9,375 kv.-a.) was installed at the Santurce Steam Station and was placed in operation in April 1946, thus raising the capacity of this station to 31,250 kv.-a. To further avert a serious power shortage during a period of extreme drought, a floating steam plant, the *Seapower*, was acquired from the War Assets Corporation. This plant, with a capacity of 37,500 kv.-a., was berthed at Cataño and placed in operation in August 1946. In December of the following year, a new 6,250 kv.-a. unit was placed in operation at the Mayagüez Steam Station, raising the installed capacity of the plant to 11,250 kv.-a.

In the early part of 1949 the Caonillas Hydroelectric Project was completed and placed in operation, and the installed generating capacity of the integrated system was augmented by 22,000 kv.-a.

The new San Juan Steam-electric Station at Puerto Nuevo started operating by the end of 1950 with two 23,529 kv.-a. units, and the *Seapower* plant was sold during the same year.

As of July 1952, the generating facilities of the island-wide interconnected system consisted of 17 hydroelectric plants with a total capacity of 96,575 kv.-a. and four steam-electric plants with a total capacity of 123,087 kv.-a. (table 19).

The demand for electric power in Puerto Rico has been increasing in recent years at a very rapid rate due primarily to industrial expansion. During a period of 15 years from 1935, production of electric power was increased by more than six times (table 20). The rate of increase has been greatest since about the end of World War II. Electric power generation on the island rose from nearly 299,500,000 kilowatt-hours in 1944-45 to over 698,300,000 in 1951-52. The general increase in power generation requirements now appears to be at an average rate of over 70 million kilowatt-hours per year.

Assuming that the steam-capacity may take care of about 65 percent of the total demand, it would seem that with the rate of increase in electric power requirements, all of the potential hydroelectric possibilities of the island would be put to use by 1975. These are rough estimates, but barring unforeseen developments in the power generation field, they clearly indicate that all the available water power will be needed within the near future. This rapidly accelerating demand for power results in part from the industrialization program and in part from the expansion of the domestic load.

Projects now under construction will materially increase the installed generating capacity to meet the steadily increasing demand for electric energy by the people and the industries of the island. In the fall of 1951, a third generating unit went into service at the new San Juan steam-electric plant, thus raising the installed capacity at this plant to 70,587 kv.-a. A feature of the Caonillas extension project is a 5,000 kv.-a. hydroelectric plant which started operation early in 1952. A capacity of 32,500 kv.-a. will be added by the hydroelectric plants included in the Southwestern Puerto Rico Project. Present schedules for the construction of this project indicate that a 10,000 kv.-a. plant will be ready for operation by the end of 1953 and a 22,500 kv.-a. plant by the end of 1955.

Table 19.—Statistical data on electric power plants and related reservoirs in Puerto Rico, July 1952 ¹

System	Rated capacity	Average yearly output	Average operating head	Drainage area	Average annual stream flow	Utilization factor	Reservoir area	Useful storage
PUERTO RICO WATER RESOURCES AUTHORITY								
Hydro plants:	<i>Kv.-a.</i>	<i>1,000 kw.-h.</i>	<i>Feet</i>	<i>Square miles</i>	<i>Acre-feet</i>	<i>Percent</i>	<i>Acres</i>	<i>Acre-feet</i>
Dos Bocas.....	22,500	30,880	145	170.00	283,000	94.9	634	24,072
Caonillas.....	22,000	60,000	482	50.00	150,000	97.5	700	46,708
Garzas No. 1.....	9,000	18,200	1,210	6.25	21,000	88.4	108	4,213
Garzas No. 2.....	6,300	13,600	798	7.00	24,000	87.2	108	4,213
Toro Negro No. 1.....	10,800	34,900	1,610	10.68	34,000	80.2	157	4,755
Toro Negro No. 2.....	2,400	3,200	630	1.57	7,200	87.1	54	1,810
Río Blanco.....	6,250	22,850	1,320	6.00	50,000	41.5	-----	8
Comerio No. 2.....	4,000	9,500	140	133.00	180,000	52.8	60	500
Comerio No. 1.....	2,000	11,100	169	133.00	180,000	44.0	60	500
Carite No. 3.....	800	3,390	217	7.92	30,000	64.2	333	9,500
Arecibo.....	900	3,380	166	27.20	60,000	48.9	-----	0
Total.....	86,950	211,000	-----	-----	-----	-----	-----	-----
Steam plants:	70,587	Estimated potential output at percent P. F.					<i>Percent P. F.</i>	<i>Kw.-h.</i>
		Kilowatt-hours generated per gallon of fuel oil:						
		12.8	-----	-----	-----	-----		
		7.7	-----	-----	-----	-----		
		8.0	-----	-----	-----	-----		
San Juan.....	31,250	7.7	-----	-----	-----	60	130,000,000	
Santurce.....	11,250	8.0	-----	-----	-----	60	48,600,000	
Mayagüez.....	10,000	7.6	-----	-----	-----	60	42,000,000	
Ceiba (leased).....	123,087	-----	-----	-----	-----	-----	640,600,000	
PUERTO RICO IRRIGATION SERVICE								
Hydro plants:		<i>1,000 kw.-h.</i>	<i>Feet</i>	<i>Square miles</i>	<i>Acre-feet</i>	<i>Percent</i>	<i>Acres</i>	<i>Acre-feet</i>
Carite No. 1.....	4,200	11,500	742	7.92	30,000	63.9	333	9,537
Carite No. 2.....	800	5,000	335	7.92	30,000	67.7	333	9,537
Total.....	5,000	-----	-----	-----	-----	-----	-----	-----
ISABELA IRRIGATION SERVICE								
Hydro plants: Four.....	4,625	-----	-----	24.5	79,000	-----	-----	32,500

¹ Source: Water Resources Authority.

The Water Resources Authority owns most of the electric generating and distribution facilities on the island. Other electric properties include those of the Isabela Irrigation Service, an instrumentality of the Puerto Rican Government, and the Puerto Rico Irrigation Service, also a unit of the local Government which is operated by the Authority at cost.

The Authority has interchange connections with these other electric utilities and also interconnections with sugar *centrals* which utilize cane bagasse for fuel. The interconnections with sugar mills enable the system to procure surplus power generated by these *centrals* during the grinding season. Since the grinding season coincides ap-

proximately with the dry season, a small reduction in the demand on the hydro system is realized at the time when the supply of water is restricted.

The potential water power that may be economically developed from streams in Puerto Rico in their present condition is estimated at about 700 million kilowatt-hours a year. Out of this total some 230 million kilowatt-hours have been developed to date. The Southwestern Puerto Rico Project and other minor projects now under construction will augment this total to about 350 million kilowatt-hours within the next 4 or 5 years. Therefore, within less than 6 years, half of the present potential waterpower resources of the island will be developed. Because of the relatively

Table 20.—Electric power generation in Puerto Rico ¹

Fiscal year	Total production	Increase
	<i>Kilowatt-hours</i>	<i>Kilowatt-hours</i>
1935-36	95, 628, 183	
1936-37	109, 397, 658	13, 769, 475
1937-38	128, 414, 125	19, 016, 467
1938-39	145, 753, 672	17, 339, 547
1939-40	161, 068, 188	15, 314, 516
1940-41	197, 273, 734	36, 205, 546
1941-42	236, 415, 105	39, 141, 371
1942-43	253, 373, 282	16, 958, 177
1943-44	283, 564, 275	30, 190, 993
1944-45	299, 477, 370	15, 913, 095
1945-46	351, 098, 652	51, 621, 282
1946-47	397, 425, 655	46, 327, 003
1947-48	458, 623, 810	61, 198, 155
1948-49	494, 440, 325	35, 816, 515
1949-50	537, 285, 257	42, 844, 932
1950-51	620, 225, 532	82, 940, 275
1951-52	698, 358, 162	78, 122, 630

¹ Source: Water Resources Authority.

meager hydroelectric power resources now available, hydroelectric developments are designed primarily to provide the peak load requirements of the system, and steam-electric plants necessarily have to provide the base load requirements.

Rural Electrification

Although the Water Resources Authority is actually a governmental agency, it functions as a corporation. Its funds are derived only from sales of electric energy and by the issuance of revenue bonds guaranteed by those sales. The sale of electricity in the rural areas, however, produces far less revenue than the actual cost of providing service to those parts of the island. Therefore, the Authority has not been able to offer revenue bonds to finance rural service with full assurance that the investment would yield adequate returns.

Hence, the Government of Puerto Rico made provisions under Act No. 335, approved April 16, 1946, to assign funds to the Authority to aid the rural electrification program. Under the provisions of this legislation a total of \$2,185,000 was made available by the Government during the period from 1946-47 to 1951-52, inclusive. Up to the end of June 1952 a total of 17,527 rural families had been served with electric facilities. The cost of getting this service to these families averaged about \$161 per family.

Electrification in the rural sections lags sadly behind the extension of service in the urban areas

(table 21). As of May 31, 1951, electric service reached only 14 percent of the rural dwellings although 69.5 percent of the urban dwellings had electricity available to them. The 86 percent of the rural homes on the island still without electricity represents 215,900 of the 251,000 rural dwellings. A great many of these homes are on farms, and the fact that they are without power is a serious economic drawback. Moreover, the lack of electric service in rural homes and communities is one factor which contributes greatly to the highly unsatisfactory living conditions that prevail in the country areas of Puerto Rico.

The 1950 census places the total number of rural dwellings in Puerto Rico at about 251,000. Actual counts from the United States Geological Survey maps indicate that out of this total about 120,000 rural dwellings can be served with electric service and the remaining 131,000 cannot be provided with this service economically because they are too sparsely located in the mountainous region of the island.

The rural electrification program is now entering a second stage—a stage of further expansion. This is made possible by a long-term loan of \$6,376,000 made to the Water Resources Authority by the Rural Electrification Administration of the United States Department of Agriculture. Together with funds made available to the Authority by the Puerto Rican Government, it provides for the further extension of electric power service to the rural areas of the island over a period of the next 6 years.

Table 21.—Electric service in Puerto Rico, May 31, 1951 ¹

Item	Urban	Rural	Total
	<i>Number</i>	<i>Number</i>	<i>Number</i>
Number of dwellings	190, 000	251, 000	441, 000
Number provided with electric service	132, 000	36, 100	168, 100
Percentage not provided with electric service	30. 5	86. 0	62

¹ Source: Water Resources Authority.

Plans for the 6-year period call for the construction of lines and other facilities so that electric service may be made available to approximately 29,000 rural dwellings. This will increase the number of rural consumers of electricity to about 65,000, or about 20 percent of the total rural

dwellings. As ambitious as this undertaking may seem, it is evident that many more years and much more money will be required to complete the rural electrification program so that this great segment of the island's population may enjoy the advantages and conveniences which electricity can provide.

Nevertheless, it is highly important that the rural electrification program be pushed forward with speed and vigor. Strenuous efforts need to be made to reduce the time in which it possibly may be completed so as to hasten the benefits which use of electricity in the rural areas can bring to the entire economy.

The fact that up to now the sale of electricity in rural areas has not paid for the cost of the service, although in the urban areas it has, clearly points up the necessity for promoting increased use of power in the country sections. For the Water Resources Authority this is simply as a matter of good business. So far practically no work has been done in the rural sections to encourage the use of power for economic purposes which would increase productivity and raise incomes. The Authority has pressed hard to expand its facilities to make more power available over a wider area, and this agency rightfully deserves a great deal of credit for what has been accomplished. But the fact remains that it stopped short of doing a complete job by not taking measures aimed at increasing the use of the electricity which it worked so hard to get distributed.

From the standpoint of Puerto Rico's economy and the needs of the people, there is little reason for satisfaction with the use of electric power merely for lighting up a few bulbs, running a radio, or some other similar purpose, as desirable as these may be sociologically. These are simple uses that come into being almost automatically as soon as power becomes available to a community or a farm. Unfortunately, however, such uses contribute little that directly increases production although they help improve living conditions. If the people who are served by a power line are to get the maximum benefit out of the electricity that is available to them they must use it in ways that will not only add to their conveniences but also increase their output of goods and services and add to their total incomes. In this way the entire economy gains. Moreover, the revenue from the sale

of power is thus increased, and the service stands a better chance of paying its own way.

But the use of electricity in ways that will increase productivity, lower costs, or promote efficiency is something to which people generally have to be educated. This is especially true in the rural areas of Puerto Rico, where the people have been so accustomed to outmoded methods and techniques that they usually are slow to adopt significant changes in ways of getting things done. And yet, there are so many opportunities for improving economic conditions in the rural sections by increasing the use of electricity for production purposes that it calls for proper emphasis and attention. Electricity could be the starter for many small rural industries and enterprises. The employment of electric power on farms alone offers large potentialities. There are around 400 farm uses for electricity, and many possibilities still remain to be explored.

The answer to the problem of increasing the use of electric power in the rural areas rests largely with the Water Resources Authority. It is the one agency in Puerto Rico that can provide the overall leadership and coordination that would be required in this particular field. The Authority should move to inaugurate a complete program to increase power use on farms and in rural communities. This may well be done at small cost by establishing within the organizational structure of the Authority a small unit headed by a competent person who would be responsible for enlisting the cooperation of other governmental and private agencies, planning the scope of activity, developing the necessary informational materials, and providing the guidance and coordination that would be needed in carrying out the educational and other activities entailed in a power use program. Any help and advice needed in developing such a program could undoubtedly be obtained from the Rural Electrification Administration.

The actual work of carrying out the power use program in the field and of reaching farmers and others in the rural communities need not be done by the Authority. This should be left to the cooperating groups such as the Extension Service and private business interests, including those concerned with the manufacture or distribution of equipment and supplies. Banks could also

participate along with other agencies such as the Production Credit Association, Farmers Home Administration of the United States Department of Agriculture, Soil Conservation Service, Puerto Rican Department of Agriculture, the Economic Development Administration, and many others. The educational and demonstration activities that could be carried on by all these groups would undoubtedly have a tremendous impact on power use in the rural areas and everyone would benefit.

The Authority, through its unit in charge of the rural power use program, would also work through other groups in the development of power equipment by focusing attention on the special needs of farmers and other rural people in an effort to encourage research and the manufacture and distribution of equipment to meet these requirements. Such agencies as the Agricultural Experiment Station could cooperate very effec-

tively in research on farm power utilization and the development of equipment and techniques for farm use.

There is a great deal to be gained through an effective rural power use program operating in Puerto Rico in conjunction with the distribution of electricity. The experience of the private power companies and the rural electrification cooperatives in the States shows that the rural use of electricity can be increased if a real effort is made to do so. Many of the private companies employ farm power advisors and have special departments for the purpose of promoting wider use of electricity in country areas. Electric cooperatives throughout the mainland have set the pace in various activities to increase the use of power on farms and in rural communities. These efforts have paid off well. Their application to the problem in Puerto Rico should be similarly productive.

3. Domestic and Industrial Water Supply

Water for domestic, commercial, industrial, and public uses is supplied to various parts of the island by the Puerto Rico Aqueduct and Sewer Authority. This is an autonomous public corporation created in 1945 to operate all water works and sewer systems on the island then under municipal management. Its purpose is to provide an adequate water and sewer service.

Up to 1945 most of the systems limited their water service to a number of hours daily. In most cases the water did not meet the standards of the United States Public Health Service. Under the present arrangement the public is receiving 24-hour daily service and the water meets the standard requirement in 99 percent of the total flow. The progress attained so far has contributed to the improvement in public health and the reduction of the death rate.

The Aqueduct and Sewer Authority operates in 6 districts, each district consisting of approximately 13 municipalities with their respective wards. The population is segregated into urban and rural. Although there are more people in the rural areas, the number in the urban areas has been increasing in recent years. In 1940, the area now covered by the 6 districts of the Aqueduct and Sewer Authority had 641,366 urban and 1,167,899

rural people (table 22). The population of the 6 districts in 1950 totaled 931,563 urban and 1,277,393 rural dwellers.

Table 22.—Population in aqueduct districts of Puerto Rico, 1940 and 1950 ¹

District	1940		1950	
	Urban	Rural	Urban	Rural
San Juan.....	261, 059	198, 742	413, 493	232, 409
Arecibo.....	59, 968	283, 927	84, 089	288, 235
Mayagüez.....	99, 799	211, 905	115, 028	236, 954
Ponce.....	103, 125	128, 408	149, 053	184, 858
Guayama.....	44, 784	148, 221	68, 104	142, 368
Humacao.....	72, 631	196, 696	101, 796	192, 569
Total.....	641, 366	1, 167, 899	931, 563	1, 277, 393

¹ Source: Aqueduct and Sewer Authority.

Information on population changes is of vital importance in planning future water requirements for domestic, public, and other uses since facilities have to be geared to the prospective needs. In the decade between 1940 and 1950 the increase in urban population was at an average rate of about 29,000 per year, or a total increase of a little more than 45 percent for the period (table 23). The increase in the rural population averaged nearly

11,000 per year, and the gain from 1940 to 1950 was only slightly more than 9 percent.

Table 23.—Population changes in aqueduct districts from 1940 to 1950¹

District	Urban	Percent-age	Rural	Percent-age
San Juan.....	152, 434	58. 4	33, 667	16. 9
Arecibo.....	24, 121	40. 2	4, 308	1. 5
Mayagüez.....	15, 229	15. 2	25, 049	11. 8
Ponce.....	45, 928	44. 5	58, 450	43. 9
Guayama.....	23, 320	52. 1	—5, 853	—3. 9
Humacao.....	29, 165	40. 1	—4, 127	—2. 1
Total.....	290, 187	45. 2	109, 494	9. 4

¹ Source: Aqueduct and Sewer Authority.

The 6 districts of the Aqueduct and Sewer Authority are now supplied with water flowing from 173 installations (table 24). These include

Table 24.—Water supply installations in aqueduct districts¹

District	Filter plants	Partial treatment plants	Deep wells	Rural aqueducts
San Juan.....	4	2	3	10
Arecibo.....	3	6	3	35
Mayagüez.....	3	4	4	5
Ponce.....	1	7	8	9
Guayama.....	1	3	7	25
Humacao.....	2	9	0	19
Total.....	14	31	25	103

¹ Source: Aqueduct and Sewer Authority.

103 rural aqueducts, 25 deep wells, 31 partial treatment plants, and 14 filter plants. Each district has varying installations to supply the water required.

The amount of water produced by the various installations in the 6 districts of the Aqueduct and Sewer Authority approximated 21 billion gallons for the year 1950–51 (table 25). Most of this water was produced by filter plants which for that year had an output of slightly more than 16¼ billion gallons. The partial treatment plants produced a little more than 2¼ billion gallons, and deep wells supplied somewhat more than 2 billion gallons of water. The rural aqueducts produced only a little more than 365 million gallons of water.

Table 25.—Water output by installations in aqueduct districts, 1950–51¹

District	Filter plants	Partial treatment plants	Deep wells	Rural aqueducts
	<i>Million gallons</i>	<i>Million gallons</i>	<i>Million gallons</i>	<i>Million gallons</i>
San Juan.....	11, 087. 657	32. 934	94. 695	38. 144
Arecibo.....	956. 363	378. 587	165. 323	105. 291
Mayagüez.....	1, 994. 986	373. 021	187. 234	23. 792
Ponce.....	1, 230. 245	600. 582	1, 369. 632	38. 005
Guayama.....	288. 649	177. 200	293. 520	103. 265
Humacao.....	727. 702	740. 604	-----	57. 041
Total.....	16, 285. 602	2, 302. 928	2, 110. 404	365. 538

¹ Source: Aqueduct and Sewer Authority.

Most of the water from the installations in the 6 districts of the Aqueduct and Sewer Authority is distributed in the urban areas. Water consumption for domestic, industrial, commercial, and public uses in the urban areas approximated 18¼ billion gallons for the year 1950–51 (table 26). Per capita consumption in these urban areas averaged a little over 53½ gallons per day.

Water consumption varies greatly in the different towns of the island. In towns of the mountain sections and those outside of the sugarcane areas the consumption of water is lower than in those towns close to the coast. Also, it is to be expected

Table 26.—Consumption of water distributed in urban areas, 1950–51¹

District	Population	Total annual consumption	Daily consumption per capita
		<i>Million gallons</i>	<i>Gallons</i>
San Juan.....	413, 493	10, 981. 383	72. 76
Arecibo.....	84, 089	1, 481. 293	48. 26
Mayagüez.....	115, 028	2, 509. 251	59. 76
Ponce.....	149, 053	3, 153. 374	57. 96
Guayama.....	68, 104	723. 125	29. 08
Humacao.....	101, 796	1, 394. 522	38. 20
Total.....	931, 563	18, 242. 948	53. 65

¹ Source: Aqueduct and Sewer Authority.

that families with sewer facilities consume more water than do those without sewer facilities. In the city of San Juan, for example, per capita consumption of water for all classes of users without sewers is 77 gallons per day (table 27). For those users with sewers it is 111 gallons daily.

Table 27.—San Juan daily per capita water use with and without sewers ¹

Use	Water use with sewers	Water use without sewers
	<i>Gallons</i>	<i>Gallons</i>
Domestic.....	54	36
Commercial.....	33	17
Industrial.....	6	7
Public (schools, hospitals, parks, etc.).....	18	17
Total.....	111	77

¹ Source: Aqueduct and Sewer Authority.

Cities like Ponce, Mayagüez, and Arecibo require water at a daily rate of 60 to 70 gallons per capita. This compares with only 11 gallons per capita daily for the rural population.

Requirements for water for industrial purposes are increasing, especially in the San Juan district. These greater needs for the San Juan section are easily met by the facilities in the metropolitan and adjacent areas as far as Río Grande which supply 50 million gallons of water daily. The two main sources of this water are the Río Grande de Loíza and the Bayamón River. Water from the Río Grande de Loíza is treated in the Loíza Plant with a capacity of 30 million gallons daily which can easily be increased to 60 million. Water from the Bayamón River is treated at the Guaynabo plant, which has a daily capacity of 30 million gallons.

The Río Grande de Loíza has a catchment area of 205 square miles with an annual median precipitation of 76 inches. The catchment area of the Bayamón River is only 27.3 square miles, and

it has the same annual precipitation as the Loíza. However, during the dry year 1947, with the help of drawoffs from the 1,700 million-gallon capacity Cidra Reservoir, the Bayamón River contributed with a runoff of 250,000 gallons per square mile, which was proportionally equal to the Loíza River runoff.

Outside the San Juan district, facilities for meeting the water requirements of large-scale industrialization are far from satisfactory. The facilities available in these other districts, however, probably could be augmented.

Most of the catchment areas of the present water systems have a minimum normal capacity of runoff greater than the volume required to satisfy the present demands of the towns served. The source facilities for some of the towns, however, will have to be increased within 20 years.

Altogether, the present supply and distribution of water provides fairly well for the existing domestic, industrial, commercial, and public requirements of the urban population. On the other hand, it meets the needs of only about 16 percent of the rural population (table 28). Funds provided annually by the Puerto Rican Government would take care of the water needs of an additional 24 percent of the rural population, raising to 40 the total percentage of the rural people served. This estimate, however, is tentative for many reasons, among them being the increasing tendency of people to shift from rural to urban areas and the creation of new communities sponsored by governmental agencies.

Each district has aqueducts to serve its rural areas. In addition, there are extensions from urban water systems which have greatly helped

Table 28.—Total distribution of water served in rural areas ¹

District	Total population	Population served	Percent population served	Percent population unserved	Million gallons yearly	Daily gallons per capita
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
San Juan.....	232, 409	76, 100	32. 7	67. 3	272. 049	9. 70
Arecibo.....	288, 235	23, 795	8. 3	91. 8	125. 271	14. 00
Mayagüez.....	236, 954	14, 675	6. 2	93. 8	69. 782	13. 00
Ponce.....	184, 858	24, 020	13. 0	81. 0	85. 090	9. 70
Guayama.....	142, 368	35, 665	25. 1	74. 9	139. 509	10. 70
Humacao.....	192, 569	29, 014	15. 1	84. 9	130. 825	12. 00
Total.....	1, 277, 393	203, 269	15. 9	84. 1	821. 524	11. 00

¹ Source: Aqueduct and Sewer Authority.



An expanding system of public fountains supplies good water to an increasing number of rural families.

the rural people. These extensions are a byproduct of the Aqueduct and Sewer Authority's efforts to integrate as many local urban water systems as possible. Thus, a water main which starts at Río Piedras supplies the towns of Carolina, Canóvanas, Río Grande, and Palmer. All the rural area along the 16 miles of this line is benefited with a supply of water. A similar situation exists in connection with the following integrations: Caguas-Gurabo, Aguadilla-Aguada-Moca, Fajardo-Ceiba, Humacao-Las Piedras, San German-Lajas, and Isabela-Quebradillas.

In the 6 districts of the Aqueduct and Sewer Authority there are 103 aqueducts that serve as sources of water for their rural areas, and these supply about 365½ million gallons of water a year (table 29). Extensions from integrated urban lines total 110, and the water served by them for rural use approximates 456 million gallons a year.

Up to now the Legislature of Puerto Rico has appropriated relatively small amounts for rural aqueducts. The revenue obtained from this investment is negligible since few rural families are in position to pay for the water service. Most of the people come to the public fountains installed by the Aqueduct and Sewer Authority along the roads. Although the initial cost of providing water service is paid from public funds, even the costs of operation, maintenance, and depreciation which the Authority must meet are greatly in excess of the income received from the rural dwellers. The urban dwellers help pay for this cost by the rates they are charged.

The task of extending the water system so as to meet the needs of every rural ward is one that is far beyond the present means of the Aqueduct and Sewer Authority. Therefore, future progress depends on the Puerto Rican Government's ability to provide the necessary funds.

Expenditures made in connection with the construction of rural aqueducts from 1945 to 1951 totaled \$4,000,200 on 322 projects. Of this amount, a total of \$3,272,580 went for 218 constructed by the Authority with an additional \$609,000 for 45 aqueducts under construction or soon to be constructed. A total of \$79,115 was spent on 26 aqueducts constructed in cooperation with the former Farm Security Administration. Other

Table 29.—Water distributed in rural areas, by sources of supply ¹

District	Aqueducts			Extensions			Total		
	From own source	Million gallons yearly	Population served	From urban lines	Million gallons yearly	Population served	Million gallons yearly	Population served	Daily gallons per capita
San Juan.....	10	38. 144	6, 805	29	233. 903	69, 295	272. 047	76, 100	9. 7
Arecibo.....	35	105. 291	18, 595	10	18. 980	5, 200	124. 271	23, 795	14. 0
Mayagüez.....	5	23. 792	3, 275	17	45. 990	11, 400	69. 782	14, 675	13. 0
Ponce.....	9	38. 005	11, 120	16	47. 085	12, 900	85. 090	24, 020	9. 7
Guayama.....	25	103. 265	25, 735	9	36. 244	9, 930	139. 509	35, 665	10. 7
Humacao.....	19	57. 041	8, 799	29	73. 784	20, 215	130. 825	29, 014	12. 0
Total.....	103	365. 538	74, 329	110	455. 986	128, 940	821. 524	203, 269	11. 0

¹ Source: Aqueduct and Sewer Authority.

aqueducts surveyed and designed in part but not constructed total 33 and have involved an expenditure of \$39,504.

Ground Water Resources

The replenishment of the ground water resources of Puerto Rico is of vital importance not only as an aid in meeting municipal and industrial requirements but also in supplying the irrigation and hydroelectric needs.

Although the total precipitation which falls in most of Puerto Rico is ample to meet all water needs, critical shortages arise in certain parts of the island, particularly along the south coast, and there are seasonal shortages throughout most of the island. These deficiencies together with the increasing requirements emphasize the need for more effective use of the total supplies of water available and the importance of putting into effect adequate measures for the improvement, expansion, and conservation of water resources. This requires dealing with the problem of each watershed and determining the protective measures needed on the basis of such factors as geological conditions, vegetative cover, rainfall, and runoff.

The principal ground water recharge sources in Puerto Rico are: (1) Rainfall, (2) stream flow, and (3) irrigation. Most of the ground water reservoirs are recharged from rainfall, particularly in the interior of the island; streams take care of ground water recharge in the alluvial areas of the eastern, southeastern, and western parts of the island; and recharge from irrigation is important in the south coast area and to a lesser degree in the northwest coast.

The largest ground water developments in Puerto Rico appear to be those found in the south coast, the Lajas, Guanajibo, and Mayagüez valleys, and the Arecibo-Bayamón and San Juan sections of the north coast. The total average pumpage of ground water on the island has been estimated as at least 250 million gallons daily. Probably 200 to 250 million gallons per day are pumped from wells for irrigation, 15 to 20 million gallons for industrial purposes, and 7 to 8 million gallons for public supply. Several million gallons a day are also pumped for domestic and stock use in rural areas.

Small to moderate supplies of ground water for domestic uses and small industries are also found in most parts of the island. The only possible

exceptions are the low rainfall areas of the southwest coast and those marshy areas where the ground water is salty.

Wide differences in the rates of ground water recharge and discharge occur on the island, largely because of the great range in the amount and distribution of rainfall and the permeability of the soils and rocks. These variations may occur not only in different places but at different times in the same place.

One of the outstanding examples of artificial recharging in Puerto Rico is that which occurs from irrigation in the south coast. Similar recharge takes place in the Isabela Irrigation District, although this is of lesser economic importance. Also of little economic importance is the recharging that occurs as a result of the leakage in the Guajataca Reservoir. An example of artificial recharge through wells is found at the glass plant near Cataño.

Induced recharge is another practice of artificial recharge. An outstanding example is found in the south coast, where the water table has been drawn down by pumping from wells, so that some water from rainfall which formerly ran off at the surface now enters the ground. Similarly, streams now lose more water to the ground during flood conditions than was lost when the water table was higher.

The principal use of ground water in Puerto Rico is for irrigation of sugarcane. Of approximately 950 wells, 300 are used for this purpose. Of these, 200 are located in the Patillas-Ponce section. It is estimated that the total pumpage of ground water for irrigation of sugarcane on the island may exceed 250 million gallons a day. A relatively small number of wells, of rather small capacity, are used for irrigation of citrus fruits, pineapple, and miscellaneous fruits and vegetables, and for watering livestock.

The use of ground water for domestic supply depends chiefly on wells. These may be either drilled or dug. It is believed that a large proportion of the dug wells will yield contaminated water. Many drilled wells are also polluted. This is due largely to the location of the wells near buildings and other sources of pollution. Some wells have been dug principally for watering livestock. In some areas these yield water too salty for human consumption but tolerable for livestock.



Many families in rural areas of Puerto Rico still obtain their water supplies from unsafe sources.

Of the 77 municipalities on the island, 25 obtain their public water supply from wells alone, or their supply is partially supplemented by streams or springs. There are also additional ground water systems in the suburbs of the cities and in the rural areas. Most of these consist of a well and a storage tank to which the people come to obtain water; a few include distribution systems. Army and Navy installations also supply part of their needs from ground water sources. Sugar *centrals* such as Aguirre have installed wells for public supply in many of the surrounding settlements. Some hospitals, schools, resorts, etc., have provided their own wells.

The requirements of ground water for industrial purposes are certain to increase in future years. Through the efforts of the Economic De-

velopment Administration alone more than 150 new industries have been established during the past few years. In addition, sugarcane *centrals* and rum and alcohol distilleries require large quantities of ground water. The processing and canning of fruits require water in moderate quantities. Many of these plants obtain their water from wells. The cement plants, paper, tile, and footwear factories depend on wells. The iron works in Ponce and some public utilities are also using ground water. Most of the water required by sugarcane *centrals* is for general purposes, including domestic supply and washing. In addition some use is made for boiler feed, maceration of cane, and for cooling and condensing. Most of this water is needed only during the cane grinding season. It is estimated that as much as 25 million

gallons of ground water are required each day during the grinding season, as compared with 2 to 3 million gallons daily during the remainder of the year. Industrial wells other than those of sugar *centrals* may produce as much as 4 to 5 million gallons of water daily.

To meet the increasing needs for water it will be necessary in many cases to tap new sources of supply or extend existing sources. In many of the rural areas additional supplies of water may be developed through the activities of the soil conservation districts. This is already being done successfully in some communities. It has shown its possibilities in the wards of Maricao of Vega Alta and Pugnado of Vega Baja where the farmers have organized committees to raise funds and to allocate labor and responsibilities for carrying out their projects.

Under such an arrangement involving the soil-conservation district, the communities may provide labor, casings, pipes, pumps, and other materials needed. Machinery and equipment for digging and drilling the wells may be obtained through purchase, hire, loan, or grant. In this connection, it may be possible for such agencies as the Puerto Rican Department of Public Works or the Land Authority to make available to the soil conservation district, either on a rental or loan basis, any suitable machinery and equipment that may be temporarily idle. The soil conservation district would receive from the community in which the digging or drilling of the wells is done a small fee to pay for the cost of the fuel, maintenance, salary of the equipment operator, and a small amount to assist in paying for the cost of the equipment.

The heavy pumping of ground water that is now taking place and the need for increasing supplies calls for various measures that will provide the basis for intelligent action in safeguarding the total supply. There is need for some intensive investigations to determine the effect that pumping is having on ground water in such areas as the south coast, and to determine what control measures should be put into effect to maintain the supplies of water. Also, ground water investigations are needed to determine the quantities available and the location of the sources throughout the island. This is particularly needed for the Bayamón-Arecibo section, for such valleys of the west and east coasts as the Añasco, Guanajibo,

and Yabucoa as well as for some sections of the interior of the island.

Of great help in developing information that would reveal what is happening to the ground water resources would be the establishment of observation wells. By periodic measurements of the water level in these wells, it would be possible to determine the fluctuations taking place in the ground water levels. This work could be initiated in the public supply wells of the Aqueduct and Sewer Authority.

The recharging of underground reservoirs is important to maintaining the supply of water. Investigations are needed to determine the feasibility and means of recharging underground reservoirs, particularly in areas where excessive pumpage is taking place. Some of the methods that may be considered are: Spreading water over alluvial fans or other porous areas; using natural stream channels, ditches, basins, furrows, wells, or pits; and flooding.

Water Rights and Concessions

The practice of utilizing water from streams under government concessions in Puerto Rico dates back to Spanish colonial times. Until 1898 those franchises were obtained by grant as "concessions" from the Spanish Crown. From then until 1917 they were obtained by application to the executive council and, more recently, by application to the Public Service Commission. Such grants amount to a considerable proportion of the ordinary stream flow of most of the rivers in the south of the island, and exceed the low flows of those rivers. Little official attention seems to have been given in the past to determine the actual quantities of water used, or to the need for the water.

With concessions for the use of water now under the supervision of the Public Service Commission, all applications for permission to use water from streams are referred for approval to the Water Resources Authority, the Aqueduct and Sewer Authority, and the Department of Health. The right granted is always a revocable permit, subject to cancellation at any time that a case of greater need for public use of the waters in question arises.

Concessions for the use of waters granted by the Spanish Crown prior to the Treaty of Paris

were recognized by article VIII of this treaty. These concessions were to be respected as vested rights, and unless their beneficiaries relinquished or surrendered them to the new government, these could not be impaired in any way. Further legislation and judicial interpretation reiterated this principle in authorizing the owner or owners of such water rights or concessions to negotiate with government officials.

The law relating to water rights in force in Puerto Rico dates back to June 13, 1879. This basic legislation was amended by acts of March 12, 1903, and March 9, 1905. It is believed that, in general, the law is adequate for regulating the use of surface waters, but difficulties arise out of the water rights themselves. In relation to ground water rights, the law recognizes some principles which are incompatible with ground water hydrology and with the fundamentals of basin-wide management for optimum yield.

Practically all flowing surface waters of the south watershed of the island have already been committed to use by law. They are used principally for irrigation of sugarcane lands along the coastal plains. These legal rights introduce serious problems in the development of a water supply in this area. In fact, unless a major part of such supply is diverted from nonconcession streams of the north watershed, no rivers of the south slopes appear feasible of development because of the existing water rights.

The laws affecting ground waters of Puerto Rico also date back to the Spanish colonial times. Water now plays a far more important role in the economy of Puerto Rico than it did when these laws were enacted. For this reason it is important that the law be brought more nearly in line with present needs so that provision may be made for greater protection of the water resource in the public interest. The provisions of law governing water rights should, in the light of present advanced knowledge, be revised so that they are more compatible with ground water hydrology

and with the fundamentals of basin-wide management for optimum yield.

In view of the essentiality of ground water to the economy and its widespread use on the island, the law governing water rights might well declare that all ground waters are public waters and subject to appropriation when in the public interest.

Provision might well be made in the law so that any change in the location of a well or in the use of the water is prohibited unless application is made to the agency administering the law. Such agency should be responsible for determining whether any such change will impair existing rights before granting a permit to make the change. In granting the permit, the agency should require the proper plugging or repair of the well that is involved.

Wells for domestic and stock water purposes should be exempt from the operation of the law. Wells used for these purposes make a relatively insignificant demand upon the water supply, and such an exemption would prevent possible hardship. It would be advisable, however, to require owners of such wells to furnish such information with respect to them as may be needed by the agency administering the law.

The law could also provide that all determinations of the agency administering it, in granting or refusing permits, determining vested rights, designating areas or subareas of ground water supplies, or forfeiting rights for a nonuser, should be subject to appeal to the courts within a specified time by any aggrieved party. Otherwise, such determinations of the agency should be final.

Over all, wherever water rights or concessions are involved, it is important for the protection of the resource that a good measure of scrutiny be given to the actual amounts of water used, the efficiency of utilization, and the necessity of the use that is being made of the supply. Technical and other assistance should be readily available to water users so that they may be in position to cooperate effectively in the wise use and conservation of the island's water resources.

4. Water Pollution

The natural water resources of Puerto Rico are subject to serious pollution as a result of the great density of population and the lack of adequate control measures. Despite this danger, large

numbers of people use untreated water direct from the source of supply for drinking and other household purposes.

There is hardly a stream on the island that does

not have an intake of wastes from domestic or industrial origin. These discharges, if untreated and uncontrolled, find their way into streams and ground waters and are detrimental to the many uses to which the different bodies of water are put. Natural bathing places are rendered dangerous to public health, water supplies become strong links to the development of epidemics, high water treatment costs are made unavoidable, industrial and agricultural production costs are increased, and fish and animals are threatened with destruction.

Island-wide water pollution control programs are relatively new to Puerto Rico although various measures have been applied in the past to meet particular problems in local situations. Such programs are necessary to maintain water quality or to restore its condition so that the water may be suitable for the various uses to which it may be put.

The bodies of water of Puerto Rico are mostly low-flow streams with very little capacity to recover from the continuous intake of sewage and industrial wastes to which most of them are subjected. This has given rise to acute problems of water pollution. One of the most critical now on the island is that of the San Jose Lake and the Martin Pena Channel, both within the metropolitan area of San Juan. Industrial wastes from rum distilleries, soft-water bottling plants, pharmaceutical products factories, and other sources are discharged directly, or through the sewerage system of San Juan, into the lake and the channel. Moreover, about 30,000 people are discharging their domestic sewage into these bodies of water. There are also hundreds of small shacks located at the edge of the lake in slum areas, which have their latrines built directly over the water of the lake. Such uncontrolled pollution has been a menace to public health and has been the cause of the death of thousands of fish and the production of foul-smelling gases which are a real nuisance to the large populated area and its surroundings.

Another problem of great importance is that of the excessive pollution of the Yaguez River, at Mayagüez. This river has a very low-flow capacity. In addition, because of tidal effects, the mouth of the river is filled with sand most of the time, thus preventing free flow of the river water into the ocean. From the discharge of wastes of two breweries and other plants as well as from many other sources in the area, the water of the river, which is stagnant, becomes highly septic at

certain seasons. Generation of hydrogen sulphide from the anaerobic decomposition that takes place causes a foul odor and destroys the oil paint on houses located in the area surrounding the main stem of the river.

There are many other similar problems in various parts of the island. If nothing is done to control the pollution of the different bodies of water, conditions will grow worse with increasing damage to the economy.

Action Taken To Control Pollution

The Puerto Rico Department of Health has been greatly concerned with the water pollution problem, and has given attention to various abatement measures. In 1947, the Puerto Rican Legislature enacted Law 444 which created a Commission for the Control of the Bodies of Water in Puerto Rico. This Commission was charged with the responsibility of dealing with all problems related to water pollution.

A section was created within the Bureau of Sanitation of the Department of Health, whose chief, a sanitary engineer, served as the advisor on technical matters to the Commission. Immediately after the section was organized, the work on abatement of pollution was started. Problems reported by local health units on the island were considered and different surveys were made to establish the fact that uncontrolled pollution was causing damage. There was, however, no program of organized action.

In 1950, the Legislature passed Law 142, which repealed Law 444 and all others which were in conflict with the new act. This new act designated the Department of Health as the Puerto Rican agency to intervene in everything related to pollution of the waters of the island and vested in the Secretary of Health authority to prevent and abate water pollution in Puerto Rico, as well as to establish rules and regulations for the purpose. It also fixed penalties for the violation of any of its dispositions and established the administrative and judicial procedures to be followed in handling violations. Also created was the Water Pollution Control Advisory Board, which advises and consults with the Secretary in connection with the administration of the act.

The work on control of stream pollution is assigned to the Section of Stream Pollution and Industrial Wastes of the Bureau of Sanitation.

The personnel of this section includes a sanitary engineer, a chemist, sanitary inspectors, and sample collectors. The section also uses the personnel of the local public health units and public health laboratories.

After Law 142 was enacted, the Department of Health developed plans for a water pollution abatement program. With the aid of funds granted to Puerto Rico under the Federal Water Pollution Control Act, Public Law 845, enacted in 1948, personnel and equipment became available. A field brigade composed of an engineer, a chemist, a sanitation inspector, and a driver was created for the purpose of carrying on field work.

During the year 1951 surveys were made in three basins. These included the Yaguez River drainage basin, the Tallaboa River drainage basin, and the Añasco River drainage basin. The work is to be continued until all of the bodies of water on the island have been covered.

In the survey, which represents the initial phase in pollution abatement work, the field brigade attempts to determine and locate all possible sources of pollution of a river basin, from the mouth of the river to its headwaters. Samples of the river water are taken at variously located sampling stations to determine general conditions of the river and the effect of pollutants in the river water. The samples are analyzed in a mobile laboratory to determine dissolved oxygen, biochemical oxygen demand, alkalinity, acidity, and chlorides. No bacteriological analyses are made in the field because of the lack of personnel and equipment.

The second phase of the work includes the development and application of measures necessary to abate existing pollution. The determinations resulting from the field work are analyzed in the central office where the necessary corrective measures are developed. The local public health units are advised of the corrective measures required to be taken and they are responsible for notifying property owners and enforcing the needed action.

In the Yaguez River drainage basin survey, a total of 209 samples was collected and analyzed. Arrangements have been made with the public health unit for the application of corrective measures. Owners of 146 houses which were discharging wastes into the river were notified and given 30 days in which to eliminate the discharges to the river. At the same time four dairies were notified of the deficiencies which made their wastes

pollute the river. Also, meetings to work out a solution to the pollution problem were held with officials of the Aqueduct and Sewer Authority and with representatives of three plants which were the most important sources of contamination.

The survey of the Tallaboa River drainage basin resulted in a total of 79 samples being taken and analyzed by the field brigade. The field work lasted about 2 months. Measures to reduce pollution on this river are being developed.

The Añasco River drainage basin survey covered one of the four largest rivers of the island. This river has a very large drainage basin extending from the town of Adjuntas, in the Cordillera Central, to the western coast of Puerto Rico, at the Mona Passage. About 560 samples were taken in the survey during about 6 months. The river and all its tributaries were covered. Even though there are some industries discharging wastes into the river, the general condition of the river's waters is good. However, some corrective measures will have to be taken in certain instances.

The Department of Health plans to continue its recently inaugurated pollution abatement program so that the island may be covered within a reasonable time. This agency hopes to be able to complete the survey of about 15 basins every year, so that within 5 or more years the whole island will have been covered and all the bodies of water surveyed to determine pollutional loads and the corrective measures that may be applied for pollution abatement.

Special problems met in the pollution abatement work on the island have spurred various investigations to determine possible solutions. A research project for determining the most practical and efficient method for treating sugarcane mill wastes has been planned, using personnel and laboratory facilities of the island's School of Medicine. The Department of Health hopes that some method for the treatment of sugar mill wastes will be worked out so as to eliminate the very heavy pollutional load that is discharged in every place where a sugarcane *central* operates. The School of Medicine is also doing research to determine a practical and efficient method for treating the industrial wastes of rum distilleries.

The conditions of extreme pollution of the San Jose Lake and the Martin Pena Channel give rise to serious difficulties which are of wide concern, especially in connection with new housing projects.

Arrangements have been made with Federal agencies which assist in the construction of housing projects so that a combined use of funds from the Aqueduct and Sewer Authority and the municipal and insular housing authorities will be made for the purpose of working out a solution to the big sanitation problem that exists in the area from Isla Verde to El Condado in Santurce. This area has no sewerage system and the sewage from the many homes is now discharged into the two bodies of water.

Problems and Needs To Be Met

No scientific estimate has been made to determine the economic loss which results from pollution of the bodies of water in Puerto Rico, but, without doubt, it is considerable. On different occasions, during past years, as a result of excessive pollution, thousands of dead fish have appeared on the surface of the San Jose Lake and the Martin Penn Channel, and in many other bodies of water on the island. The destruction of animal and vegetable life in these waters represents a great loss of income for the many people who make their living from fishing. In other places, the source of water for cattle and other livestock has been destroyed.

Water treatment costs are greatly increased when the source of drinking water is polluted with either human or industrial wastes. An example of this is the Loíza River water, which is used as a source of drinking water for the San Juan metropolitan area. Chemicals used in treatment procedures are greatly increased on account of the discharge of the industrial wastes from two sugarcane mills located in the surroundings of the Loíza River and from four sewerage systems which discharge directly into this body of water. Other benefits to be derived from water resources such as recreation, boating, sport fishing, etc., are destroyed by pollution.

The island has 34 sugar mills and 13 distilleries. On account of their high content of organic matter, the wastes from these factories constitute a heavy source of pollution when discharged into a body of water. Also, many of the new industries established on the island in recent years discharge their liquid wastes into bodies of water, thus polluting them.

Nowadays, thanks to an activity of the Aqueduct and Sewer Authority, almost every town on

the island has a sewerage system for the disposal of its human wastes. Unfortunately, only 13 of these are provided with modern and efficient sewage treatment plants. In all others, sewage is discharged directly or with improper treatment into bodies of water, thus heavily polluting them. The establishment of new industries has boosted the urban population of the island, increasing the amount of sewage to be disposed of.

The greatest obstacle to progress in pollution abatement in Puerto Rico is the lack of funds for the construction of structures necessary to treat, and thus render harmless, pollutional loads which are discharged into the bodies of water. In 1950 the Legislature made its first allotment of \$800,000 for such works as sewage treatment plants and sewerage systems. While such an amount helps, it is far short of the total sum required to take care of the great need for pollution abatement plants all over the island.

New industrial plants to be set up in Puerto Rico have to comply with pollution control requirements established by the Department of Health. All new plants which produce liquid wastes are required to treat them so as to reduce the pollutional load to a reasonable degree. Among those industrial plants existing in 1947 when Law 444 was enacted, it has been very difficult to apply corrective measures for abating pollution. Lack of funds by private enterprises has been a great obstacle to this work. In the case of distilleries and sugarcane mills, no treatment process is known that is available for immediate application. That is why the Department of Health has granted funds to the School of Medicine for research work to investigate treatment procedures for these wastes.

The problem of pollution of streams and other waters requires the attention of the Government and the people of Puerto Rico for many reasons, the most important being the transfer of pathogenic organisms of infectious diseases by the continuous intake of sewage. Polluted waters are vehicles for the transmission of diseases such as bilharziosis, typhoid fever, cholera, and dysentery. Most epidemics of typhoid fever have had their origin in waters polluted with human feces. The esthetic values involved are also important. A heavily polluted stream is a nuisance to the senses of sight and smell. Polluted streams cause economic losses to industry and agriculture, increase

the costs of treating drinking water, and result in damage to aquatic life. All these harmful effects can be prevented by maintaining a sound program for abatement of water pollution.

The Puerto Rican Government should rate sewage disposal as important in the modern community as is the supply of drinking water. Still more funds will have to be appropriated for supplying sewage-treatment plants to all existing sewerage systems which do not have adequate disposal facilities. To reduce pollution dangers, every town on the island would have to have a sewerage system and sewage-treatment plant.

Also, more funds for the pollution abatement are needed by the Department of Health. This program is now being carried on almost completely with Federal funds granted to Puerto Rico by virtue of Public Law 845. The money now available is wholly inadequate. More funds are necessary to increase personnel and facilities in order to achieve pollution abatement more efficiently and in a shorter period of time. The time factor is a very important one in view of the serious nature of the pollution problem that exists in Puerto Rico.

The rural areas are severely handicapped by the lack of sanitary facilities and the lack of

knowledge concerning sanitation and health. The situation is deplorable in many respects since it involves the health and welfare of such a large segment of the total population of the island. More sanitation work needs to be done in the rural sections with greater emphasis on the proper disposal of human feces and other wastes such as garbage. The great deficiency in health education that exists among rural people will have to be met head on by positive action to overcome widespread ignorance which now results in a tremendous waste of human, as well as economic, resources.

All of the agencies functioning in the rural areas can contribute to the improvement of health conditions, provided the Health Department assumes its proper role of leadership in this situation. For example, the Extension Service, which reaches in the remote corners of the island, could cooperate more effectively with the Health Department in a unified rural health program, as could many other agencies, including the rural schools. Local civic organizations and business groups could cooperate also in conducting clean-up campaigns and other activities designed to boost interest and pride in sanitation and good health by means of encouraging self-help.

5. Flood Control

The most damaging floods in Puerto Rico are usually the result of the heavy precipitation which accompanies tropical hurricanes. Records show that 67 hurricanes passed over or near Puerto Rico during the period from 1915 to 1945. From 1945 to 1951 no major hurricanes have passed over Puerto Rico. Some damage to crops, especially to coffee, resulted from the winds and rains of a hurricane which passed near the island in August of 1950.

With the exception of the flood-control examination studies conducted by the United States Army Engineers, Puerto Rico District, under authority of the Flood Control Act approved by the 76th and 77th Congresses, no survey or study has been conducted in Puerto Rico to determine the extent of damage and the flood-control measures required. In the work that was done, the Army Engineers made preliminary flood-control examinations of 10 of the more important river sys-

tems in Puerto Rico. These included the Portugués-Bucana, Bayamón-Hondo, La Plata, Yaguez, Estero, Guamaní, Lapa, Susua, Chico, and Maunabo and Quebrada Arena Rivers.

One of the principal problems encountered was the difficulty of separating damage to crops and property caused by floods from the damage resulting from the effect of winds and rains. In addition, the information available as to losses is not limited to the flooded areas of the streams, but is spread over the entire area covered by the particular storm.

When floods occur most of the damage to cane fields and pasture lands is not severe, provided the water recedes within a reasonable time. The greater part of the damage caused in these areas results from the erosion of river banks. This has been brought about by undercutting of the existing stream bank, thus causing the river banks to collapse into the stream, and in some cases altering

or changing the stream course for some distance. Damage from floods to cropland in the south coast has resulted chiefly from the filling in of drainage and irrigation ditches with debris and silt. Floods have also caused damage to highways and to urban areas in different parts of the island.

A great deal of the damage from floods can be reduced by the use of the land according to its capability and the application of soil conservation measures. Much of the flood damage is due to soil erosion caused by the lack of forest or other protective cover and by clean cultivation, particularly of tobacco and other crops grown on extensive hillside areas which are too steep for cultivation and located near the headwaters of the streams.

General recommendations for each of the major rivers in Puerto Rico may be found in the preliminary flood-control reports prepared by the Army Engineers. Some of the more important engineering recommendations made by these reports include: (1) Construction of additional reservoirs for conservation storage of floodwaters; (2) straightening, widening, and deepening river channels; (3) construction of retaining walls or dikes where needed; and (4) replacing or remodeling of highways and of pumping facilities to remove storm water runoff.

One of the most important recommendations that needs to be carried out is the development of sound coordinated flood-control plans for every watershed in Puerto Rico in order to assure a well balanced and truly effective program for the pre-

vention of flood damage. Piecemeal flood control, where only a part of the watershed is considered, will not be effective. A coordinated plan should be prepared by the Federal and Puerto Rican agencies concerned. These should include the Soil Conservation Service, Forest Service, Production and Marketing Administration, Aqueduct and Sewer Authority, Water Resources Authority, the Puerto Rican Department of Agriculture, and the Experiment Station.

Flood control must begin where the rain first hits the land. It is first necessary to get the land to absorb as much of this water as possible. The excess that cannot be absorbed should be held or retarded on the fields by means of soil conservation measures applied to the land as needed. Adequate control must be exercised for every acre, from the top of the watershed down to the place where the river empties into the ocean.

In addition to the need for a coordinated program, group action on the part of farm owners and operators should be encouraged to facilitate dealing with problems of watershed extent. This may be done through the soil conservation districts or through the formation of watershed associations where the areas overlap into different districts.

Greater emphasis should be placed on creating public understanding of the soil and water resources problem in Puerto Rico and the importance of corrective measures which will also contribute to flood control. This is important in both rural and urban areas.

6. Drainage

Proper drainage is the removal of excess water from any soil or field as quickly as necessary for satisfactory growth of the crop which is to be grown. This water may be in the soil voids or may come as runoff from the surrounding places at higher elevations. For Puerto Rico where land is so scarce, the reclamation through drainage of swamps and other low areas subject to frequent overflows is important, but effective drainage of lands already under cultivation is probably still more important.

There are about 250,000 acres of soils which need provision for drainage if crops are to be produced successfully. Poorly and imperfectly drained soils of Puerto Rico include the alluvial soils of the in-

ner plains and river flood plains, the terraces and alluvial fans, and the coastal plains and lowlands. About 40 percent of them are fertile soils of the river flood plains which are mostly devoted to sugarcane cultivation. Infiltration tests conducted by the Experiment Station have indicated a slow infiltration rate of 0.09 inch per hour for representative soils of this group. The values range from 0.03 for Aguirre clay to 0.19 inch of water per hour for Vayas clay. Laboratory percolation determinations on subsoils have indicated rates of less than 0.01 inch per hour for Caguas clay, for Vega Baja clay, and a poorly drained phase of Lares clay. Any rate below 0.05 inch per hour is considered likely to limit the growth

of most crops. These soils are confined to level topography where percolation is impeded by some unfavorable soil condition, or where the distance to the drainageway prevents the effective movement of water at enough speed before more water is added by rainfall. Most of these lands are under cultivation.

Open ditches are used as a rule for removing excess water in cultivated fields. If well constructed, they usually have ample capacity and are able to dispose of the water quickly at a low grade. On the other hand, open ditches waste considerable land (sometimes as much as 10 or 15 percent of the area) and demand a yearly expenditure for upkeep. If not well constructed, they sometimes are ineffective, inconvenient, and may encourage erosion.

The flatland areas of organic soils planted to sugarcane require more complex drainage patterns than do mineral soils; in many cases pumps must be installed and dikes built in addition to all other ditches needed for mineral soils.

Drainage problems on many hillsides and on rolling land are limited to the disposal of runoff during excessive rainfalls. The removal of runoff must be effected with a minimum of soil losses, which under improper management may be large. Rather than a removal of water, the problem with soils of the uplands is mainly one of soil and moisture conservation. The term "drainage" under such conditions must only imply the disposal of excess runoff at a nonerosive speed.

In the case of tobacco plantations, which are often on fields with slopes of more than 40 percent in Puerto Rico, shallow ditches are dug around every plot (each plot encloses about 900 to 1,200 square feet) giving the field the appearance of a gridiron. In that way, the water travels only very short distances before entering the ditches and therefore its erosive power may be decreased.

In coffee plantations, holes may be dug 1 by 1 foot and about 8 to 12 inches deep near most of the coffee trees. During rains these holes catch runoff water and sediment and check the speed of the flow. In addition, deep long pits are dug along drainageways and hillside roads which also receive sediment and check the velocity of the runoff.

With shallow soils on the uplands there are often seepage spots where slowly permeable rock layers force percolating water to the surface.

These areas may interfere with farming operations and they must be considered when hillside ditches, bench terraces, or other conservation practices are being applied.

Land not under cultivation, but which could be cultivated if properly drained, totals around 58,800 acres. Land already reclaimed by gravity, tiles, and pumping approximates 7,500 acres.

The drainage of the area known as Caño Tiburones which is under way will provide an additional 4,200 net acres of arable land out of a total of 5,600 acres in this project. An appropriation of 1½ million dollars has been made of which about half was spent by the end of June 1951. Already about 200 acres of land in the Monte Grande, Lisas, Santa Barbara, and Tiburones farms have been made available by the lowered water table which resulted from the engineering works that have been established.

Preliminary work for the Loíza-Río Grande drainage project which covers an area of slightly more than 4,000 acres is under way. Out of around 3,500 acres to be drained, the net area of arable land will total about 2,700 acres. The estimated cost of the project is about \$865,000. Studies have been completed for draining the swampy area called "La Regadera" near Vega Baja which comprises a total area of 1,200 acres. The total cost of the project has been estimated at \$156,000.

Other poorly drained soils which could be reclaimed for agricultural uses total more than 48,000 acres. These are located in various sections of the island.

Drainage requirements are different on each group of soils and for each crop. There is need for improved drainage in the lowlands and this ordinarily calls for the establishment of properly spaced laterals, or *cruceros*, and main channels of adequate capacity. The spacing, depth, and capacity of the ditches will vary with the amount of water to be disposed of, and this in turn varies with the rainfall and soil properties.

Also, drainage is an essential part of the improvement of salty soils. Deep ditches or tiles are needed to hold the permanent water table below about 4 feet or deeper, so that salts may be carried down far enough to keep them from returning by capillary action to the crop-root zone. Until adequate drainage is provided, it is usually impossible to improve or reclaim salty soils.

Improved drainage in the upland areas is necessary. This calls for the use of hillside ditches, bench terraces, graded contour planting, and grassed waterways as the particular piece of land and the crop grown may require. Properly located hillside interception ditches will usually eliminate hillside seepage zones as well as provide runoff control. The Soil Conservation Service has done considerable work on drainage problems in Puerto Rico, and the advice of this agency should be utilized for best results.

Ditching costs vary widely from area to area according to the volume of water to be disposed, soil characteristics, and other factors. Under present conditions the cost of establishing ditches ranges anywhere between \$10 to \$40 per acre in Puerto Rico. Maintenance costs are much lower, ranging from \$5 to \$12 per acre. In recent years the Production and Marketing Administration has made incentive payments for the construction of open drainage ditches on farms. These

payments, made under the Agricultural Conservation Program, should be continued since properly constructed ditches contribute to conservation as well as to improved crop production.

Since providing proper drainage tends to be rather costly, there is need for developing improved methods and techniques for removing excess water. Studies should be made of the possibilities of subsoiling to break compact soil layers and allow quicker percolation of water. Also, studies should be made of the possibilities of tile and mole drainage systems. Use of chemicals and other materials that may improve soil structure should be examined to determine their practicality from the standpoint of effectiveness and cost. In view of the common use of ditches, there is need to determine the proper spacing and depth of open ditches under varying conditions. In connection with all the work on drainage, there is need for intensifying research relating to water movement in soils and other physical properties of soils.

7. Wildlife and Recreation

The fields, forests, and waters of Puerto Rico were once well stocked with birds and fish, but this wildlife has dwindled until now there is very little left.

The most important game birds and mammals of Puerto Rico at present are the Zenaida and the white-winged doves, the white-crowned and the scaled pigeons, resident and migratory waterfowl, and the feral goats and pigs of Mona Island. The bird population has declined seriously during the first half of the present century as a result of the destruction of their preferred habitat through thoughtless clearing of woods and other various agricultural activities, merciless hunting, and hurricanes. In certain cases, these forces have resulted in the actual extermination of some species.

Attempts to manage game in Puerto Rico were begun only in recent years. The first move was the setting aside of game lands as refuges or sanctuaries and providing hunting restrictions. Up to now 18 refuges with a total area of 96,191 acres including marshlands, lakes, and forested areas, have been established. The game law and regulations limit the annual take by prescribing hunting seasons, fixing bag limits, and restricting the time and manner in which game may be taken.

After several years it is clear that laws establishing refuges and restrictions on hunting cannot by themselves bring back the constantly decreasing game supply. The laws must be enforced, and a proper management program is essential to increase the amount of game available.

Wildlife management has become increasingly complex. Increases in the number of hunters, and the problems of diversified land use, make necessary a great deal of factual information for intelligent wildlife management. As a matter of fact, little is known about the life history and the needs of most of the game species of Puerto Rico. The various forces at work must be understood before an effective wildlife restoration program can be put into operation.

Puerto Rico participates, with the 48 States and Territories, in Federal aid to wildlife restoration under the Pittman-Robertson Act. With an annual allotment which has ranged from \$5,000 to \$8,500 since 1948, investigative work has been conducted to obtain current information on populations, distribution, production, natural enemies, food habits, migratory movement, and kill of important game species.

Table 30.—Gun pressure for doves and pigeons, 1950

Area	Hunting trips reported	Average kill per trip	Zenaida dove	Cuban white-winged	W. I. mourning dove	Scaled pigeon	White-crowned pigeon
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
South-southeast.....	130	6.39	4.86	0.79	0.40	0.25	0.09
Southwest.....	77	4.83	3.61	.43	.06	.23	.50
North-center.....	63	3.79	2.71	.60	-----	.22	.26
Northwest.....	24	3.08	2.50	.12	-----	.46	-----
East-northeast.....	15	3.86	2.61	.26	-----	.26	.73

Count of Waterfowl and Doves

An annual census of waterfowl populations, covering both migratory and resident species, was started in 1950. This census which is carried on by plane, rowboat, and automobile, is a valuable tool for measuring the seasonal fluctuations in duck populations, and serves as a basis for developing native-duck hunting regulations from year to year. A waterfowl census, carried on by boat on August 16, 1950, showed that nearly 1,700 Caribbean coots, Antillean grebes, and ruddy ducks were using the Guánica, Cartagena, Tortuguero and Quintin lagoons. All these birds are resident species.

A census carried on by plane on December 14, 1950, revealed that 687 migratory ducks (blue-winged teals and lesser scaups) and 755 native ducks were using the same lagoons. Since these censuses comprised the first waterfowl inventory, comparisons with past years cannot be made. The study is to be continued and will help determine population trends and annual production indices.

The usefulness of dove population indices taken at periodic intervals is well established as a tool in wildlife management. For the sound management of the Zenaida dove, the most popular game bird in Puerto Rico, it is necessary to determine its general, overall population movements, designate population segments, and to determine annual rate of turnover in the dove population.

Hunting and Kill Data

Information obtained at three waterfowl checking stations temporarily established at Cartagena, Anegado, and Guánica lagoons, showed that the average sportsman bagged 2 or 3 ducks for his total kill during the first 3 days of the 1950-51 duck season. A total of 98 hunters visited the lagoons in the first 3 days of the duck season and

only 251 birds were shot. The migrant blue-winged teal made up 49 percent of the birds taken, while the native coot made up 33 percent and the ruddy duck and other species, including Antillean gallinule, Antillean grebe, least grebe, and the migrant baldpate, made up 18 percent. Of the birds killed, 49 percent were migratory North American birds and the remaining 51 percent were resident species.

A total of 164 questionnaires sent at random to sportsmen revealed that hunters averaged 7 or 8 trips in the dove and pigeon season for 1950 with an average of 4 or 5 doves per trip and 1 pigeon every other trip. The season kill per hunter was about 33 doves and 4 pigeons. An analysis of the kill showed that the Zenaida dove made up 75 percent of the season take, while the Cuban white-winged and the West Indian mourning doves, the scaled and the white-crowned pigeons constituted 10.75, 3.6, 5.1, and 5 percent respectively. The gun pressure in 1950 in five different hunting areas is indicated in table 30.

In conjunction with the study of the kill and relative abundance of doves, pigeons, and waterfowl, information is also obtained as to the nesting success of game species. Observations made in the Guánica Insular Forest during the peak of the breeding season of the Zenaida dove revealed that out of every 100 dove nests with eggs, only about 37 produced fledgelings. This is a relatively low nesting success, the most important detrimental ecological factors being rats, mongoose, rain, wind, and diseases.

Another major part of this wildlife study is the examination of doves in hunters' bags during the course of the shooting season, to determine sex ratio, juvenile-adult ratio, and breeding condition. This information is helpful in determining previous season production and the abundance of actually nesting birds.

The kind and the quantity of food are among the most important limiting ecological factors in game production. Since 1949 much progress has been made in ascertaining the native foods utilized by doves and pigeons in Puerto Rico. Data on food habits is essential since one of the most important methods for increasing wildlife is the widespread establishment of feed crops.

Feeding Grounds Need Development

The investigations being conducted with the Federal aid funds for wildlife restoration indicate that certain wildlife management measures should be put into effect, particularly regarding waterfowl.

In Puerto Rico 24 reservoirs, lagoons, and mangrove swamps, with a total area of approximately 10,000 acres, constitute the only waterfowl habitat. Of these, 18 are reservoirs ranging in size from 39 to 972 acres and having a total area of 5,612 acres. They are operated or controlled by the Water Resources Authority, the Aqueduct and Sewer Authority, or by sugarcane estates. Water-control practices employed at these reservoirs are based on particular requirements such as hydroelectric power production and irrigation, and the needs of water for domestic, commercial, industrial, and public consumption.

The most important factor detrimental to waterfowl at the reservoirs is the extreme or irregular fluctuations in the water level. It is difficult to establish true aquatic plants where water levels fluctuate widely. When the water level in a reservoir goes down marsh plants begin to die off, and this usually happens at the season when migratory waterfowl are present and native ducks are more abundant. As a result, most of the reservoirs are biological deserts insofar as wild-duck food is concerned.

If the present water-control practices at the reservoirs cannot be modified to even out the water levels, other measures should be taken. These should include the construction of lateral pools where the water level could be controlled independently, thereby permitting the separate development of stabilized areas without appreciably reducing the storage capacity of the reservoir. In areas subject to irregular fluctuations where stabilization of water is not feasible, improvement of waterfowl feeding grounds must be accomplished through the planting of foods that

can survive these unfavorable conditions. This calls for considerable experimentation to find plants which are suitable for seeding on the bare shores and mudflats left by the annual January-July drawdown. In addition, upland patches should be planted and developed for the benefit of waterfowl.

The project under way on the southwest coast for the irrigation of the Lajas Valley calls for the draining of the Anegado, Cartagena, and Guánica lagoons, which are the most important waterfowl areas. Cartagena Lagoon is the best and most important breeding ground for resident waterfowl as well as the most important refuge for migrant water birds. It also supplies food and refuge for thousands of other beneficial birds which are not primarily marsh birds. Altogether, 105 species of birds are found at Cartagena Lagoon and its immediate vicinity. Another 42 species breed there either regularly or occasionally. Of the 42 species, 19 might be called typical lagoon species. Nine of these are entirely dependent upon the marsh for food and shelter, while 10 visit it primarily for food.

The planned drainage of Cartagena Lagoon will probably mean the extermination of certain species of birds as far as Puerto Rico is concerned, and a great diminution in the numbers of others. Many of these birds are of great value either to the farmers or to the sportsmen. Drainage of the Cartagena Lagoon would also divert fresh water from Laguna Rincón and this would greatly reduce the oyster colony in the eastern part of Laguna Rincón, and perhaps in other areas of that lagoon. Before the complete draining of Cartagena Lagoon is undertaken, careful consideration should be given to its development either as a private or, preferably, as a public wildlife preserve where birds would be strictly protected while breeding, and hunting carefully regulated and supervised at other seasons.

Mona Island, with its 14,000 *cuerdas*, is a habitation of approximately 3,500 feral goats, 700 feral pigs, the remnant of the rock iguana (*Cyclura stejnegeri*), and thousands of doves and pigeons. Information is secured systematically each year and compared with past conditions to determine the trend in pig and goat population. The male-female ratios determined so far indicate that the goat population has kept ahead of the number taken by hunters each year. At least 1,000 goats

could be removed annually from the herd without endangering reproduction. At the present time hunters, Coast Guard men, and fishermen take only about 350 goats per year.

Mona is very dry. In order to assure a continuous supply of water for its wildlife, four rain water catchments with underground cisterns and access ramps have been constructed. At least six more "gallinaceous guzzlers" must be constructed to meet the water requirements of the wild animals established on that island.

Commercial Marine Fisheries

Puerto Rico is surrounded by water, yet the catch of fish is very limited. The catch for 1950 was estimated at 4,225,000 pounds of fish and 480,000 pounds of lobsters, valued at \$865,500 to the fishermen. This industry employed 2,050 fishermen, 806 classified as regular fishermen, and 1,244 as casual. Most of the fishermen temporarily give up fishing when they can get a job that offers better remuneration. The following fishing craft and gear were reported operating in 1950:

Craft and gear :	Number
Dories and other rowboats.....	531
Sailboats.....	322
Motorboats.....	38
Launches.....	10
Fish pots.....	5, 226
Trawl lines.....	201
Hand lines and troll lines.....	979
Cast nets.....	414
Hawl seines.....	230
Gill nets.....	109
Weirs.....	8

Several private concerns handle the sale of fish bought from the individual fishermen. These operate mainly in the commercial fishing centers of Puerto Real, Guayanilla, Mayagüez, Fajardo, Arroyo, and other seashore locations. As a result of a lack of organization and facilities among fishermen, the marketing system favors the middleman. Consequently the fisherman's income is very low and his standard of living very poor.

For the purpose of helping individual fishermen and the fishing industry, a law was enacted by the Puerto Rican Legislature in 1951 appropriating \$20,000 for granting small loans to any fisherman in terms of fishing gear, and for promoting fishermen's cooperatives.

It seems beyond doubt that Puerto Rico could produce much more fish, but the problem of in-

creasing fish production calls for adequate refrigeration and storage facilities, improved handling and distribution of the catch, exploratory fishing to appraise the potentiality of the fishing grounds actually exploited and to discover new productive banks, economic and statistical studies on production and marketing, development and establishment of standards and grades of quality, consumer education to increase fish consumption, an adequate credit system, and mechanization of fishing boats. Fisheries' activities should be also encouraged by educational work among fishermen.

For an immediate increase in commercial fish production it is advisable to carry out small but economically sound projects which the Puerto Rican Government should sponsor since other assistance is not available to these fishermen. The development of the marine fisheries must be a slow and gradual process under the conditions in Puerto Rico.

Inland Fishery Resources

Puerto Rico has 28 streams of some magnitude and 18 reservoirs which provide (1) an unknown but fairly large poundage of fresh-water fish to rural people fishing for their own use as food, and (2) recreation to hundreds of tourists and resident anglers.

As part of the fish-stocking program which started in 1938, the large-mouth bass, bluegill sunfish, and four different species of catfish have been introduced. Fingerlings for stocking purposes are produced at the Maricao Fish Cultural Station. From 1938 to 1951, 325,011 fingerlings have been released in public and private waters. A total of 331 fish plantings have been made, 66 of them on lakes, 200 on rivers, and 65 on private fish ponds and lagoons. The lakes of Puerto Rico, virtual biological deserts prior to the introduction of North American fresh-water fishes, constitute a new source of animal protein to the rural population.

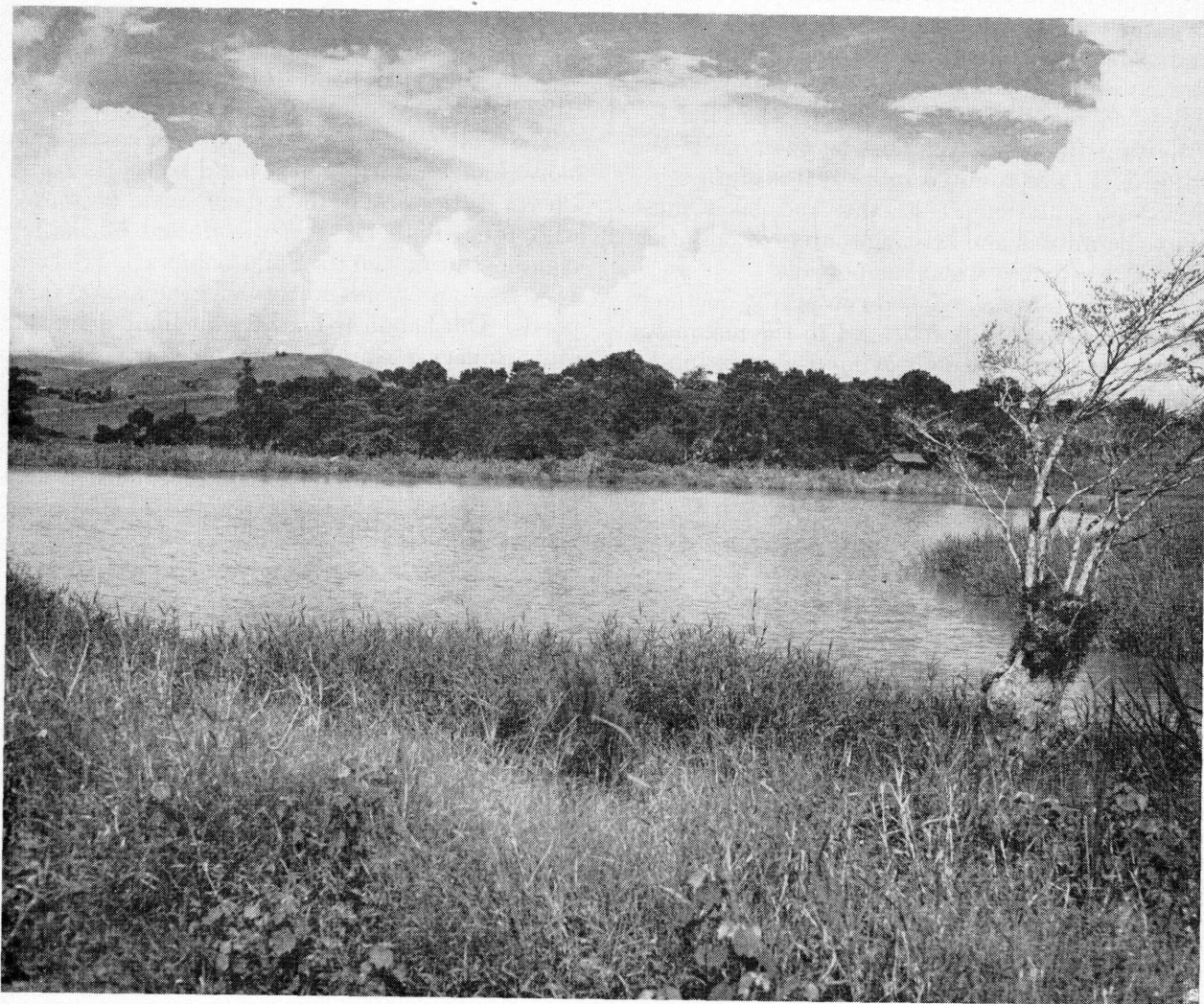
Beyond doubt the rivers and lake fisheries have been improved as to quantity and quality of fish, since the start was from a very low point of depletion. But the job is far from complete. The inland fishery resources need to be developed to the utmost for the benefit of the people and the economy. This means more extensive stocking and improved management.

The need for surveys and research to discover basic facts for establishing a fish management program is now widely recognized. In 1950 the Congress enacted the Dingell-Johnson Act which provides Federal aid for fish restoration. Under the provisions of this act, an annual allotment of \$10,000 is made to Puerto Rico for use in fish conservation and management programs. With the help of these funds, research has been started to obtain basic information concerning lake fish population, composition and trends; fish production per acre of water; annual fish catch, determined through creel censuses; effect of fluctuating water levels on bass and bluegill spawning; food habits of bass, bluegill, and catfish; effect of water pollution and sedimentation on fish production, in at least two lakes; natural food available in lakes and its rela-

tion to fish production; and chemical and physical characteristics of most important lakes and streams.

The information obtained from these studies will provide a practical guide to fish management. The findings may show that a particular lake or stream needs to be fished more or less intensively to keep its fish population in balance with food supply, or that the lake or stream has to be restocked to increase population.

In attacking the different problems in the conservation of the inland fisheries special consideration must be given to pollution, sedimentation, and fluctuating water levels. Bad farming practices and excessive tree cutting hasten erosion and create stream and lake conditions which cannot be tolerated by fish. Rapid runoff of rain waters



Farm fish ponds have a definite place in Puerto Rico and their construction deserves to be encouraged.

scour stream beds and destroy fish food. Sedimentation may bury fish spawning beds and may affect plants in two ways, one by obscuring the sunlight and thus interfering with photosynthesis, and the other by actually burying the plants. On the other hand, industrial pollution may affect fish life in any or all of three ways: (1) Direct killing of fish; (2) changes of natural conditions so that the fish seek other habitat either because of the condition of the water or the effect the industrial wastes have upon plants or lower animal life constituting fish food; (3) influence upon fish larvae and young fish, that is, upon the reproduction of the species.

In the interest of fishery and wildlife conservation, closer coordination should exist between the governmental agencies concerned with river, forest, and land use and those familiar with the requirements of the fisheries and wildlife. Fish and game laws and regulations must be respected and enforced if the wildlife resources are to be conserved for the benefit of the whole island.

Certain fundamentals must be observed if the wildlife is to be restored to its real usefulness:

1. New pollution of streams and lakes must not be permitted, and existing sources of pollution should be removed whenever possible.
2. Reforestation, and soil-conserving methods of farming must be encouraged to the maximum as important ways of improving fishing in inland waters.
3. Hatching and stocking fish must be accompanied by the protection and restoration of habitat.
4. Sewage should be adequately treated before it is poured into streams.
5. In planning the drainage of lakes and marshes consideration should be given to measures for the protection of fish and waterfowl.
6. Management of fish and waterfowl should be on a crop basis with the preservation of breed-

ing stock a matter of first concern. Blasting of fish out of ponds or other waters should never be tolerated.

7. Farm ponds are needed for effective soil conservation. Many of them should be made on the headwaters of tributaries.

Farm fish ponds provide food and recreation and are important in soil and water conservation. Some ponds have been built during recent years, and their number should be increased in the next decade. Properly managed, a farm pond may yield from 300 to 600 pounds of fish per acre, or much more than the average food production of an equal area of farm land. Sound management of farm ponds includes stocking with proper species in proper proportion, fertilization, and harvesting the fish crop regularly. Greater encouragement of farm pond construction through agricultural conservation program payments and Insular Government assistance would thus provide an additional source of food for the people as well as conserve water.

The Soil Conservation Service estimates that more than 400 farm ponds could be successful in Puerto Rico. Most of these ponds could be stocked with fish. Both the Production and Marketing Administration and the Soil Conservation Service assisted land owners in the construction of farm ponds. One handicap has been the limited amount of machinery or equipment suitable for farm pond construction. This could be remedied by the Puerto Rican Legislature authorizing loans to the soil conservation districts for the purchase of the necessary equipment. This equipment could then be made available to the land owners for the construction of ponds on a fee basis which would help repay the loan. Also, temporary idle equipment owned by Puerto Rican agencies such as the Department of Public Works and the Land Authority might be made available to the soil conservation districts for use in farm pond construction.

Chapter VI

Land for Forests and Tree Crops

Few areas of the world have experienced a deterioration of their forest land resources such as Puerto Rico has known. What was once a forest-covered island has been largely denuded by the great pressure of a rapidly expanding population exerted against very limited natural resources. Four centuries of human activity have not only removed the timber from all lands suited for continuous cultivation or grazing, but they have also stripped steep, sloping hillsides and mountains of their protective tree cover with disastrous results to these areas and the island's economy.

As used here, the term "forest land" is defined as land for which the best suited crop is a closed tree cover, or forest, without regard to the present cover or use of the land. Forest is the best suited crop where it produces a higher sustained yield, in terms of economic or social benefits, than other crops. The yield from forest may be in the form of timber, fruits, fibers, and drugs, or, because forest is superior to most other crops in controlling erosion and regulating streamflow, it also may be partly in terms of soil and water conservation. Or it may be in the form of environment for outdoor recreation or valuable wildlife.

Forest land resources include the land itself, as a source of forest production, and any timber cover which grows upon the land. Wise use of these resources requires the dedication of all the forest land area to its highest permanent use, the growing of highly productive forests upon it, and the complete utilization of all products of these forests.

Forest will grow in any part of Puerto Rico, as is evidenced by the fact that it was entirely forest-covered when Columbus arrived. Much of the island today produces greater returns from other

than forest crops, however, so that only a portion is forest land.

The Forest Lands and Their Condition

It is at present impossible to locate satisfactorily the forest lands of Puerto Rico by simply comparing the returns from forest and nonforest crops. There are few local data as to the cost of establishing and caring for forests, the yield which they will produce, and the probable future value of that yield. Moreover, changing demand and the development of new production techniques may cause frequent changes in the relative desirability of forest and nonforest crops on any specific area.

One category of forest lands is recognized by all: Those areas which because of excessive slope (nearly all lands of more than 50 percent slope, according to the Soil Conservation Service), heavy rainfall, or shallow, infertile, or poorly drained soil cannot be cultivated or pastured continuously without soil deterioration or very low yields, yet which can produce trees as a permanent crop. The area of such forest land in Puerto Rico, estimated from studies of topographic and soil maps, is not less than 600,000 acres, or nearly one-fourth of the land surface of the island. It includes almost all of the land in capability class VII. Forest on this land would protect numerous watersheds and provide a large volume of timber. Wise use and management of all of this area should be the immediate goal of a forestry program. At the same time, there should be a halt to the deforestation that is still continuing in the few sections remaining with protective tree cover.

A recent inventory by the Puerto Rican Forest Service shows that only 119,000 acres of the 600,-



Forest streams run clear. This, the Río Hicaco, in the Caribbean National Forest in the Liguillo Mountains, drains an area of steep slopes covered with loose sandy soil and subject to nearly 200 inches of rainfall per year, yet the forest helps hold the soil and keeps the water clear.

000 acres of forest lands are covered with timber forests. The volume of all types of wood in these forests is estimated at 105 million cubic feet. These remaining forests have been repeatedly cut over, removing the larger, more useful trees of the better species, until the stands are now composed largely of trees of poor quality. The volume of saw timber, about 13.5 million cubic feet, is less than 1 percent of what it was at the time of discovery. More than 80 percent of the area now forest-covered has been cleared periodically for temporary cultivation. Grazing by cattle and goats has eliminated young trees from some of the forests.

The timber cover that still remains, although abused, is of value for more than its wood. It protects some of the most important sources of water. It maintains a loose, porous surface soil which can absorb a maximum of rain water. Water absorbed by forested soils cannot run off

the surface and cause erosion or contribute to flash floods, but reappears in the uniform clear flow of natural springs downstream. This timber cover also provides the environment for the three public forest recreation areas, and is the last retreat of many species of beneficial birds.

An additional 140,000 acres of forest land bear forest-covered coffee plantations which can be, but generally are not, so managed as to protect the soil and conserve water about as effectively as do timber forests. The trees which make up this cover are generally not of good timber species, and they yield only posts and fuelwood. The total volume of these products in this area is estimated at 74 million cubic feet. A considerable area of the coffee plantations is in various stages of abandonment and is gradually reverting to secondary forest. Such plantations protect the soil and conserve water but produce little coffee or timber.

About 20,000 additional acres of forest land, which are as much as 40 percent shaded by trees, are grazed. This type of cover is less protective than forest or coffee plantations because the tree canopy is not closed and because grazing compacts and tends to expose the soil and to cause mechanical erosion. Yields of both forage and timber are low. The open-grown trees are of poor form and of inferior species. The grazing prevents the reproduction of good timber trees. In addition, about 1,000 acres of forest land are covered by bay-rum and citron trees. These plantations are open, and their protective value depends directly upon the intensity of use of the soil between the trees. Timber yield is negligible.

The remainder of the forest land, about 320,000 acres, or more than half the total forest land area, bears no tree cover. Most of this area is subject intermittently to cultivation for tobacco, food crops, and some sugarcane. At other times it is grazed or idle. Where it is not recultivated for several years it may become covered with a tangle of young trees, shrubs, and vines, the first stage in the natural return to forest. This low brush is in no sense a productive forest, but it is of value in protecting the soil from grazing and in gradually improving its porosity and organic matter content. This large deforested area produces no wood, cultivated crops only occasionally, and poor forage. The rain water which falls upon it runs rapidly over the exposed and compacted surface, contributing to floods downstream, eroding the soil, and carrying sediment into reservoirs.

Forest Resources Abuse and Its Results

Historically, Puerto Rico has wasted its forest resources. Past use of wood for local consumption or for export accounts for not more than 20 percent of the timber which has disappeared. The rest was felled and burned or permitted to decay on the ground.

More than a century ago forest destruction reached the point where the island was no longer self-sufficient in forest products. Now about half the municipalities are less than 10 percent covered with trees, and even such small products as posts and fuelwood are locally scarce.

With the growing scarcity of wood, utilization has become much more complete than it was in the past. Charcoal burners, for example, now utilize

all stems and branches down to a diameter of 1 inch. Nevertheless, because the utility of the woods of most species has never been studied, there is a large waste in misusing for charcoal those trees which are better suited to higher uses. It is estimated that half the post and pole timber is at present used for fuelwood or charcoal. Another source of waste is the use of wood without preservative treatment. The life of many local forest products might be tripled by the use of preservatives.

The deterioration of the forests is still continuing despite the fact that it already has virtually terminated the local supply of forest products in quantity, quality, and uniformity adequate to serve as a basis for important industries. Saw timber is now so scarce that no organized market based on local materials exists. Except in a few small forest regions, no stands exist which contain 10,000 board feet of accessible standing saw timber of the better species. Ninety-five percent of the posts and poles available in present forests are not durable in the soil beyond 18 to 24 months. But they could be made far more durable by proper treatment. Since their untreated value is low, they cannot be marketed long distances from the stump because they are bulky and transportation would cost more than they are worth. Fuelwood and charcoal are becoming progressively less economic forest products because their manufacture involves a comparatively large amount of labor, the cost of which is rising rapidly. The present small supply and heterogeneous nature of the forest products reduce their value as raw materials for the manufacture of industrial products such as pulp and wallboard.

The growing scarcity of local forests and their products has led to the use of substitutes. Examples are concrete for house construction; metal for window frames, fence posts, and sugarcane carts; imported construction lumber and railroad ties; kerosene as a domestic cooking fuel; and fuel oil in bakeries. Some of these substitutions have come about primarily because of the obvious superiority of the substitute material, and in these cases, of course, they create a desirable rise in the standard of living.

Other substitutions, however, are at least partly due to the depletion in the supply of the local forest products and the increasing relative cost brought about by this depletion as well as by a

rise in the wages which form a large part of the cost of forest products. The trend of such substitutions is generally toward products the prices of which reflect capital investment more than wages. Such substitutions are in one respect unfortunate because some of the employment value is lost. If the substitute is from the exterior the entire employment value of the local product is lost and the island must also pay the cost of importation. Where the substitute is a metal or petroleum product another undesirable feature is the shift from renewable to nonrenewable raw materials.

At least 80 percent of the wood and wood products consumed in Puerto Rico is imported. Of this, about 40 percent is lumber, which in 1949-50 was valued at more than \$6,000,000. Costs of

water transportation to bring this lumber to the island added nearly \$1,900,000. The production of this lumber represents permanent employment for more than 800 men in offshore areas. Much of this employment might eventually be available to Puerto Rico if local forest lands are made productive.

The lack of forest cover on a large area of forest land jeopardizes agriculture because, whatever the present use of the land, it leads to lower soil permeability and greater surface runoff and contributes to serious flood hazards downstream. An indication of the magnitude of flood damage to agriculture is shown in data from the United States Army Engineers, Puerto Rico District, concerning six rivers of southern Puerto Rico with deforested forest lands in their headwaters: Río



There was a time when Puerto Rico was well covered with vegetation such as this. It now is found on less than one percent of the Island's land area.

Guamaní, Río Portugués, Río Loco, Río Maunabo, Río Lapa, and Río Guanajibo. The total area of these watersheds is 154,000 acres, of which 20,140 acres, or 13 percent, is subject to occasional flooding. Of this area 15,720 acres are productive sugarcane lands, and 430 acres are even more valuable urban lands. If an equal proportion of other watersheds is subject to flooding, the total area that may be affected by floods is about 280,000 acres.

Much of the land in forest is in such poor condition that it contributes little to the economy. For example, full use is not being realized of a great deal of the forest land dedicated to coffee. Only a relatively small area of coffee plantations is managed intensively. Even in such areas there is considerable opportunity for improvement. Large areas are merely harvested and receive no care. Productivity in these areas is low and is declining with the gradual reversion of the plantations into secondary forest. Grazed forest lands are declining in productivity because the grazing is detrimental to the trees and the soil.

Grazing or cultivation of cleared forest lands endangers the development and future of the entire island because of resulting erosion which is sedimenting reservoirs needed for hydroelectric power and irrigation, and for water for industrial and domestic use. About 75 percent of the forest lands which have been denuded lie in watersheds above existing or proposed major reservoirs. Reservoir sites are an irreplaceable basic resource and their useful life might be greatly lengthened by reforestation. Sedimentation caused by misuse of forest lands also has damaged roads and ditches.

The lack or inferiority of tree cover on a large area of the forest lands makes it impossible for the people to reap the full benefits from the potential uses of forests for recreational and wildlife purposes, as well as for the protection of water resources.

Natural forest areas suited for outdoor recreation are mostly inadequate for the local population, and the development of additional recreation facilities within the public forests is sorely needed. Developed forest recreation areas can properly serve no more than 1,000 persons at any one time, and they are seriously overcrowded during the summer season. Satisfactory overnight accommodations within these forests for tourists from

outside of Puerto Rico are limited to about 20 small cabins. The potentialities of establishing additional forest recreation areas with suitable facilities as an aid to encouraging tourism have hardly been explored.

Need for Education and Research

A greater effort must be made to educate the general public, and particularly landowners, as to the need for proper use of local forest land resources. This should include emphasis on recognition of forest land; the various values of forest cover in the production of timber, fruits, fibers, and other products; the protection of watersheds from erosion; the control of floods; the conservation in the soil mantle of water which is released gradually during dry weather as well as in wet weather; and the provision for ideal environment for outdoor recreation and beneficial wildlife.

Landowners should be shown the beneficial role of trees on their individual farms as a part of an overall plan for proper farm land use. Past experience shows that this approach must be a direct one in which qualified technicians consider carefully with the farmer his specific problems, as is done in the soil conservation district program. This approach can be most efficient and effective from the standpoint of the Government and most acceptable to the farmer if it is the responsibility of a single agency or closely coordinated group of agencies. Preferably, the landowner's interest should first be aroused by the Extension Service working through schools and other local organizations. Then, at the landowner's request, a general land-use plan for the farm should be made, followed by more detailed advice, including recommendations for the improvement and management of land on which trees are growing or should be established. Full-time forestry extension workers should be assigned to work with farmers and other groups in at least each of three critical forest land areas: the Sierra de Cayey, the south slope of the Cordillera Central, and the basins of Río Arcibo, Río Manatí, and Río La Plata.

Technically trained foresters in sufficient numbers for direct contact with farmers are not at hand. The foresters available must train and work through other educational workers. To provide the training necessary for these workers, a 2-day demonstration and training session should



Teak poles produced in 13 years. This plantation, located in the Carite Insular Forest near Patillas on an alluvial gravel soil unsuited for farming, is ready for its first thinning and will yield a large number of high quality poles.

be held annually within each soil conservation district. Participants should include the local field personnel of the Soil Conservation and Extension Services, Farmers Home Administration, Production and Marketing Administration, the District Superintendent of Schools, school principals, leaders in vocational and community education, and others.

Demonstration of good forestry on public lands should be of a more positive nature than it has been in the past. Lands within the public forests and elsewhere, which are typical of a large area of adjacent forest lands in private ownership, should be dedicated formally to the demonstration of forestry techniques which are practical for the average farmer.

The slow progress of forestry in the past has been due either to lack of knowledge or a failure to put available knowledge in the hands of the practitioner. New methods of closing the gap between knowledge and practice through education, technical assistance, and incentives should be developed. Demonstrational and pilot plant experiments are needed to show the public in general and the landowner in particular the local benefits from forestry. Demonstration of the benefits in erosion and water control, as compared with those from other crops, should be included to strengthen public opinion concerning the proper use of critical areas. The financial returns from different forestry practices should be shown by management experiments to increase farmer interest. Results

of incentive programs should be investigated to make possible the best use of funds available in the future for this purpose.

Putting in practice present knowledge will go a long way toward better forest land use, but this is not enough. There is a desperate need for new forest crops which will produce higher returns than those recognized today. The development of new tree crops, including fruits, nuts, and other nontimber products, and of new uses for timber is high priority research. Better production methods for timber and other tree crops, and practical techniques for wood preservation could also increase returns.

One of the great needs is for research that will supply the answers to many problems in coffee growing. Although this tree crop has been grown in Puerto Rico for about 200 years, cultural practices are still predicated largely upon tradition or rule of thumb with little or no scientific basis. Average yields are low, costs are high, and plantations have long been in a generally poor condition. Yet this tree crop is important for the protection of nearly 10 percent of the farm land in Puerto Rico which otherwise would be subject to extreme erosion with serious consequences to the entire economy. A sound research program designed to improve methods of production would not only be of direct benefit, but would also result in information of great value to the improvement of coffee growing in Latin American and other countries where similar conditions prevail. The scope of the research work that needs to be done on the island is such as to require the participation of both the Puerto Rican and Federal Governments.

In general, four major lines of research in coffee production should be carried out. First, there is need to identify the lands in Puerto Rico which should be devoted to coffee production: (1) Where, because of especially favorable conditions of climate, soil, or topography, coffee grows best, and (2) where coffee does or can produce greater sustained yields than other crops. This involves not only the identification of a general coffee "region," but also methods for identifying the exact location of coffee lands within individual farms, as defined by local changes in environment.

The second line of research should relate to the conservation of soil and water on coffee lands. Two standards of conservation intensity should be determined: (1) A minimum necessary to avoid

destruction of the soil through accelerated erosion and to prevent excessive surface runoff, and (2) a higher standard which in addition accomplishes the maximum level of soil productivity consistent with the economics of coffee production. Involved are cultivation practices, use of protective ground cover, mechanical structures and barriers, and application of chemical fertilizers, lime, organic matter, etc., to improve the chemical and physical properties of the soil. Also included is the study of maximum slopes which can be farmed under each intensity of conservation.

The third major line of research should deal with the management of coffee plantations and lands suitable for coffee growing. The research work should be confined to areas identified as coffee lands and only practices which satisfy the basic requirements of soil and water conservation deserve to be studied. The research required divides itself into at least three approaches to better coffee management, as follows:

1. Improvement of the environment of the coffee tree. This involves studies of light, humidity, root competition, soil, and biological factors. Light may be influenced by spacing, pruning, or thinning of the coffee shade trees. Humidity may be affected by shade density, windbreaks, and possibly ground cover. Root competition is influenced by the relative spacing of the coffee trees and by the species and age of the shade trees. The soil can be influenced by use of leguminous shade trees and ground cover, and by the application of lime, organic matter, and fertilizers. Biological factors, insects and disease, may succumb to indirect control through improvement of the environment for the plants.

2. Improvement of the coffee trees. This involves propagation of high-yielding trees, cultural practices such as pruning, early replacement of aging trees, and improvement of flowering and of the quality of the fruits.

3. Diversification of plantation yield. This involves investigation of valuable fruit or forest tree crops which might serve also as coffee shade, and of more productive crops which might partially or wholly substitute for the coffee itself and also provide adequate protection for the land.

The fourth major line of research should be concerned with the harvesting and utilization of coffee. This relates to development of improved harvesting methods, including reduction in the num-



Trees for the future are propagated in large-scale plantings. This is a planting of coffee shade trees in the Catalina Forest Nursery located in the Luquillo Mountains.

ber of pickings now necessary, and also studies of the effects of different cleaning, drying, storage, and roasting practices upon coffee quality.

A balanced program of research on coffee production is urgently needed and should be provided for by the appropriation of Puerto Rican and Federal funds. It is estimated that such a program could be initiated with \$75,000, of which at least \$50,000 should be provided by the Federal Government and the remainder furnished out of Puerto Rican funds. The research work should be carried on jointly by Puerto Rican and Federal agencies in Puerto Rico, the main participants being the Federal Experiment Station, the Tropical Forest Experiment Station of the Forest Service, and the Puerto Rican Experiment Station with other agencies, such as the Soil Conservation Service and

the Production and Marketing Administration, cooperating.

More than 1 million dollars a year are already being spent by the Puerto Rican and Federal Governments in a unified program for the rehabilitation of the coffee plantations in order to encourage growers to restore and maintain the protective tree cover that is so necessary on the steep slopes of the coffee region. Although striking results are being achieved through this program, there is little scientific basis by which the annual expenditure can be guided. The information needed, and which must be derived through a sound research program, would not only increase the effectiveness of funds being spent by the governmental agencies and also by the coffee growers themselves, but would also point the way

to possible savings to reduce the cost and at the same time place the coffee industry on a firmer footing.

Research on utilization of other forest trees is also of high priority. The decline of the fuelwood and charcoal markets makes nearly worthless a volume of heterogeneous wood material from branches and crooked stems. The possibility of industrial development centered around this and other forest raw materials should be thoroughly explored with an eye to the prospect of even greater volumes of this material in the future. A number of little-used tree species might supply adequate material for a local container industry or increase the output of the paper factory. The raw material needs of potential wood industries indicate the desirable kinds of trees that should be produced and the techniques that should be encouraged for the utilization of wood and for increasing production on forest lands.

Forest research is logically a public activity. It should be closely coordinated with forestry education, extension, and administration, and with other research programs. The local significance of forest research in Puerto Rico is at least as great as its national significance, and the cost of the program should be shared by the Puerto Rican and Federal Governments.

Strong Public Leadership Required

Over the years both the Puerto Rican and Federal Governments have undertaken various measures designed to encourage the conservation of the forest land resources. Large blocks of forest land have been set aside as public forests to assure their protective management. Some 81,000 acres of land, about half of which was acquired by purchase, are included within these public forest areas. These lands have been afforded protection from overcutting, trespass, and fire. Bare areas within their boundaries have all been reforested, and the more accessible existing timber stands have been improved by the removal of inferior trees. An extension program in forestry has been directed toward private landowners. Some 50 million trees have been produced by the Puerto Rican Forest Service and distributed to farmers by the Extension Service free of charge in the past 30 years. Most of these trees have not been planted in solid blocks and therefore do not provide all the protective benefits of forest. Literature de-

scribing the importance and value of forests has been distributed. Government assistance by the Soil Conservation Service for the conservation of 357,000 acres of farm lands has included recommendations for good management of forest lands within such farms. Recently both the Federal and Puerto Rican Governments have offered incentives for conservation practices in coffee culture in an effort to rehabilitate the coffee growing industry and prevent the cutting of the plantations.

The continued abuse of forest land resources which is evident throughout the island shows clearly that the conservation efforts made so far by the governmental agencies have been inadequate. On private lands reforestation is progressing at so slow a pace that more than 150 years will be required to reforest once all bare forest lands. Survival of the planted trees is very low, a situation often due to improper selection of species or inadequate care of the plantations. Almost no existing forests in private ownership, with the exception of some of the coffee plantation forests, have been consciously placed under good management. The destruction of coffee plantations has continued at a rapid rate in spite of the incentive program. On public lands only the first steps in good management have been taken and only in the



Mahogany is well adapted on the north coast of Puerto Rico. This 11-year-old plantation of broadleaf mahogany in the Río Abajo Insular Forest near Arecibo shows a promising land use for sinkholes in the limestone region.

more accessible areas. Very little is known as to techniques of really intensive forest management. The direct benefits of public forest management are confined to less than 5 percent of the island. The rate of increase in public forest land ownership has been only about 1,200 acres per year during the past 5 years. At this rate, acquisition of the large blocks of nonfarm land which probably should be in public forests will require nearly 300 years.

The present situation in Puerto Rico with regard to forest land resources calls for stronger governmental leadership and more positive action in a program to conserve and encourage wise use of these resources. The approach must of necessity be broader and far better coordinated than it has been up to now. The main effort should be directed toward the improvement of practices on forest lands now in private ownership. This is where education and demonstrations and technical assistance to farmers will play major roles. Where these measures alone are inadequate, they will have to be supplemented by economic incentives to forest land owners, by outright Government purchase of critical forest land areas, and by regulatory legislation to prevent serious abuse.

Public Acquisition of Forest Land

The Government should acquire, improve, and manage as public forests those critical forest lands the protection of which is of greater concern to the public as a whole than to individual landowners. Included are lands which because of their degraded condition as a result of past abuse do not offer an attractive prospect to the private landowner for improvement and management as forests. Forest lands which are protected by timber today but which are abandoned and may at any time be cleared should also be included. These lands should be acquired, not with the objective of obtaining a monopoly of local timber production or even to control a large proportion of such production, but rather to protect critical areas and to provide a reliable supplement to the anticipated future timber production of more accessible private forest lands.

Public acquisition should be confined to large contiguous blocks of forest lands where efficient large-scale public forest management will eventually be possible. Blocks of not less than 10,000 acres of forest land should be the minimum objec-

tive. About 425,000 acres lie within such blocks. On these lands the Government should demonstrate good forestry practices and multiple-use forest management, developing them for timber production, watershed protection, integrated farming, recreation, and wildlife.

Not less than 101,000 acres of forest land included in 14 large concentrations should be publicly acquired during the next 10 years. Additional forest lands will probably have to be acquired subsequently, but the amount, rate, and timing of this acquisition will depend upon the progress made in private forestry and in the development of new uses for forest land. The locations, area, and character of the 14 large concentrations where public acquisition of forest land should take place and the priority for acquisition are shown in table 31.

The benefits to be derived by the public from forestry on the areas which may be acquired in these 14 large concentrations of forest lands are summarized briefly as follows:

1. Sierra de Cayey:

- (a) Storage of water in the soil on the wet slopes of the watersheds of Río Majada, Río Guamaní, Río La Plata, Río Patillas, Río Turabo, and Río Maunabo, alleviating floods and assuring greater dry-season flow and higher well levels.
- (b) Protection of municipal watersheds for Yabucoa, Maunabo, Patillas, Guayama, and the San Juan metropolitan area.
- (c) Erosion control and minimizing sedimentation of the watersheds above Carite and Patillas Reservoirs and part of that above Comerío Reservoir, which are the basis for hydroelectric power generation capacity of 13,800 kilovolt-amperes and which serve a 16,000-acre irrigation district.
- (d) Restoration of 27,000 deforested acres to a permanent protective and productive use and assurance of such use on an additional 33,000 acres.

2. South slope of the Cordillera (Guayabal):

- (a) Storage of water in the soil in the steep headwaters of Río Coamo, Río Descalabrado, and Río Jacaguas, alleviating floods and assuring greater dry-season flow and higher well levels for irrigation.

Table 31.—Proposed public forest land acquisition program for Puerto Rico

Location	Area (in thousands of acres)					Reason for acquisition ¹			Priority for acquisition	Area to acquire within 10 years (1000 acres)
	Gross	Net forest land	Net deforested	Now in public forest	Needs assured protection	Water conservation	Soil conservation	Timber production		
Sierra de Cayey.....	70	60	27	7	53	x	x	x	I	² 23
South slope of the Cordillera:										
(a) Guayabal.....	19	18	7	-----	18	x	x	x	I	³ 9
(b) Portugués.....	42	41	9	-----	41	x	x	x	I	³ 21
(c) Guanajibo.....	25	24	4	11	13	x	x	x	I	² 1
Río Arecibo.....	33	29	3	3	26	x	x	x	I	³ 15
Río Manatí.....	36	33	11	2	31	x	x	x	I	³ 12
Río La Plata.....	24	23	19	-----	23	x	x	x	I	² 12
Sierra de Atalaya.....	25	25	14	-----	25	x	x	x	II	² 5
Northern limestone:										
(a) Guajataca.....	37	35	9	2	33	-----	x	x	II	³ 3
(b) Tanamá.....	68	55	6	7	48	-----	x	x	II	-----
Sierra de Luquillo.....	49	47	12	34	13	x	x	x	III	-----
Guánica.....	16	16	1	9	7	-----	-----	x	III	-----
Tallaboa.....	11	11	-----	-----	11	-----	-----	x	III	-----
Lajas.....	13	10	6	-----	10	-----	-----	x	III	-----
Grand total.....	468	427	128	75	352	-----	-----	-----	-----	101
Total, priority I.....	249	228	80	23	205	-----	-----	-----	-----	93

¹ "X" Benefits. "x" Benefits of unusual importance.² Recommended for acquisition by the Puerto Rican Government.³ Recommended for acquisition by the Federal Government.

- (b) Protection of the municipal watersheds of Coamo and Juana Díaz.
- (c) Erosion control and minimizing sedimentation of Guayabal and Coamo Reservoirs, which serve an irrigated area of 40,000 acres.
- (d) Restoration of 7,000 deforested acres to a permanent protective and productive use and assurance of such use on an additional 11,000 acres.
3. South slope of the Cordillera (Portugués):
 - (a) Storage of water in the soil in the steep headwaters of Río Guayo, Río Inabón, Río Cerrillos, Río Portugués, Río Cañas, Río Tallaboa, and Río Guayanillas, alleviating floods, assuring greater dry-season flow and higher well levels for irrigation.
 - (b) Protection of the municipal watersheds of Ponce and Peñuelas.
 - (c) Erosion control and minimizing sedimentation of numerous small reservoirs serving an irrigated area of about 25,000 acres.
 - (d) Restoration of 9,000 deforested acres to permanent protective and productive use

and assurance of such use on an additional 32,000 acres.

4. South slope of the Cordillera (Guanajibo):
 - (a) Storage of water in the soil in the steep headwaters of Río Duey, Río Yauco, and Río Guanajibo, alleviating floods and assuring greater dry-season flow and higher well levels for irrigation.
 - (b) Protection of the municipal watersheds of Yauco and Sabana Grande.
 - (c) Erosion control and minimizing sedimentation of numerous small reservoirs serving an irrigated area of 15,000 acres.
 - (d) Restoration of 4,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 20,000 acres.
5. Río Arecibo:
 - (a) Storage of water in the soil in the steep headwaters of Río Grande de Arecibo and its major tributaries: Río Saliente, Río Jayuya, Río Caonillas, Río Viví, Río Limón, alleviating floods and assuring greater dry-season flow.
 - (b) Protection of the municipal watersheds of Utuado and Jayuya.

- (c) Erosion control and minimizing sedimentation of Dos Bocas and Caonillas Reservoirs, which are the basis for hydroelectric generating capacity of 50,000 kilovolt-amperes.
 - (d) Restoration of 3,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 26,000 acres.
6. Río Manatí:
- (a) Storage of water in the soil in the steep headwaters of Río Grande de Manatí and its principal tributaries: Río Toro Negro, Río Bauta, and Río Orocovis, alleviating floods and assuring greater dry-season flow.
 - (b) Erosion control and minimizing sedimentation of a large reservoir proposed for hydroelectric power.
 - (c) Restoration of 11,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 22,000 acres.
7. Río La Plata:
- (a) Storage of water in the soil in the steep headwaters of the major tributaries of the Central La Plata basin: Río Usabón, Río Hondo, Río Cuesta Arriba, and Río Guadiana, alleviating floods and assuring greater dry-season flow.
 - (b) Protection of the municipal watershed of Comerío.
 - (c) Erosion control and minimizing sedimentation of Comerío Reservoir which is the basis for hydroelectric power production capacity of 6,500 kilovolt-amperes.
 - (d) Restoration of 19,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 4,000 acres.
8. Sierra de Atalaya:
- (a) Storage of water in the soil in the steep slopes of the north side of the lower Añasco Valley and in the central Culebrinas Valley, alleviating floods and assuring greater dry-season flow.
 - (b) Protection of the municipal watershed of Aguada.
 - (c) Minimizing sedimentation of roads, and ditches in the lower Añasco Valley.
 - (d) Restoration of 14,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 11,000 acres.
9. Northern limestone (Guajataca):
- (a) Protection of the municipal reservoirs for Camuy and Hatillo, and Aguadilla.
 - (b) Erosion control and minimizing sedimentation from the north slope into Guajataca Reservoir, which is the basis for hydroelectric generating capacity of 2,200 kilovolt-amperes and which serves an irrigated area of 8,000 acres.
 - (c) Restoration of 9,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 26,000 acres.
10. Northern limestone (Tanamá):
- (a) Protection of the municipal watershed of Arecibo.
 - (b) Restoration of 6,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 49,000 acres.
11. Guánica:
- (a) Restoration of 1,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 15,000 idle acres.
12. Tallaboa:
- (a) Assurance of permanent protective and productive use of 11,000 idle acres.
13. Lajas:
- (a) Restoration of 6,000 deforested acres to permanent protective and productive use and assurance of such use on an additional 4,000 acres.
14. Sierra de Luquillo:
- (a) Storage of water in the soil in the rainy, steep headwaters of Río Naguabo, Río Blanco, Río Gurabo, Río Canovanillas, Río Canóvanas, Río Grande, and Río Fajardo, alleviating floods on the eastern coastal plain.
 - (b) Protection of the headwaters of municipal watersheds of the towns of Luquillo, Fajardo, Juncos, Canóvanas, Río Grande, and the San Juan metropolitan area.
 - (c) Erosion control and minimizing of sediment contribution from the headwaters

above a proposed hydroelectric power reservoir on Río Canóvanas.

- (d) Restoration of 12,000 deforested acres to a permanent protective and productive use and assurance of such use on an additional 35,000 acres.

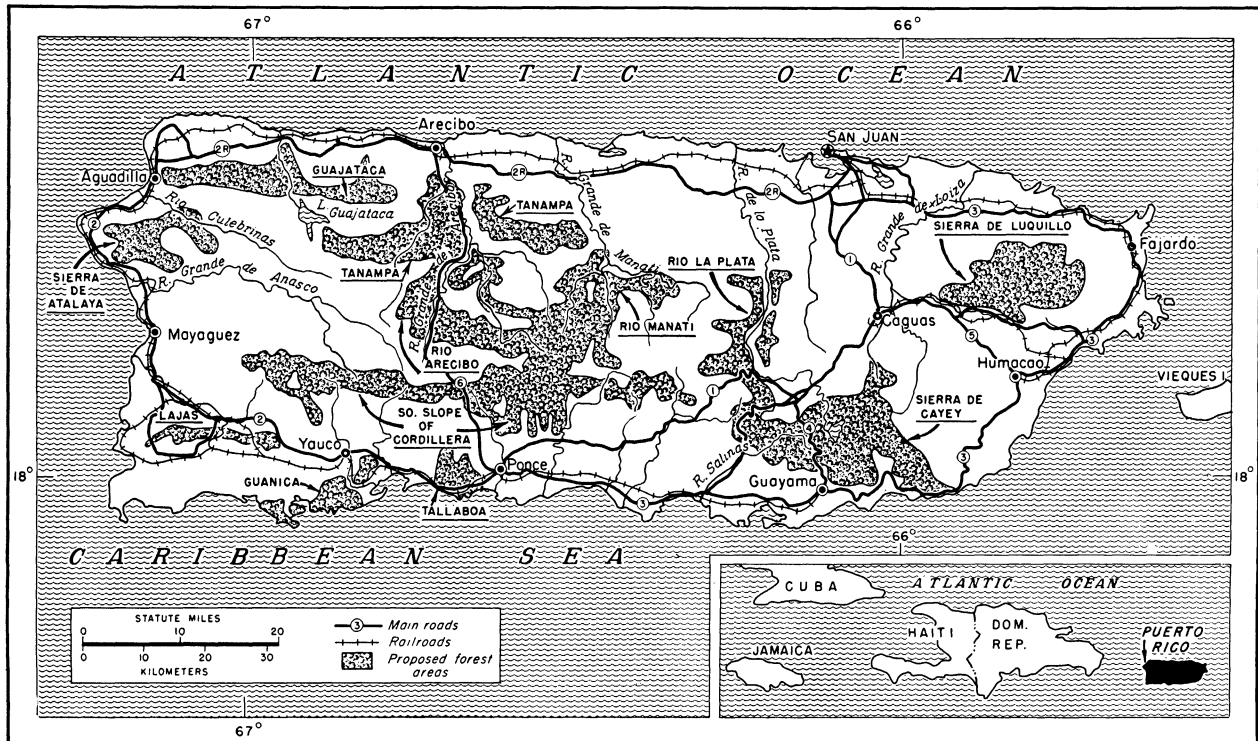
The forest areas of greatest importance in soil and water conservation are of first priority for acquisition, as shown in table 31. Those of somewhat less importance are of second priority, and those where the major benefit is only increased productivity are in third priority. The proposed public acquisition program contemplates, as a 10-year minimum, the acquisition of half the first-priority areas and at least a workable unit of 5,000 acres in each of the second-priority areas. Areas already in public forests are subtracted from these requirements. The cost of this program is estimated at not less than \$250,000 per year. Acquisition should be a joint venture of the Puerto Rican and Federal Governments, with Federal land acquisition confined to the lands adjacent to existing Federal forests, an area of 57,000 acres, costing about \$145,000 annually. The Puerto

Rican phase of the acquisition program would involve 44,000 acres, costing about \$100,000 annually.

The need for cash outlay for land acquisition might be reduced by acquiring some of the lands through tax delinquency channels. Since forest lands are now low in productivity, many are tax delinquent and revert to the Puerto Rican Government in default. At the present time these lands are resold at auction. If they were examined and considered from the standpoint of their desirability as a part of the public forest area prior to resale, they might be so classified and added to the public forests. This policy has another and more important advantage in preventing other farmers from trying to make a living in the same submarginal areas. In the long run it would also encourage emigration from areas where social services such as schools, transportation, electricity, and medical aid are costly to supply and cannot be supported by the local community.

A policy of public forest land acquisition must include realistic provisions for the people now living on lands to be acquired. The eviction of

CRITICAL AREAS IN PUERTO RICO REQUIRING PROTECTIVE FOREST COVER



Location and area covered by 14 large concentrations of forest land in Puerto Rico recommended for public acquisition over a 10-year period. A total of 101,000 acres would be improved and managed as public forests to provide critically needed protection against erosion and other destructive forces.

all people should not be a prerequisite of public land acquisition for forestry. The average landowner cannot afford the legal proceedings connected with eviction and, therefore, acquisition of some of the most abused farms would be delayed indefinitely, and the abuse of the land would continue. Also, forced eviction is not necessarily a social gain, since people required on short notice to move are apt to appear promptly in slums elsewhere and present a social problem.

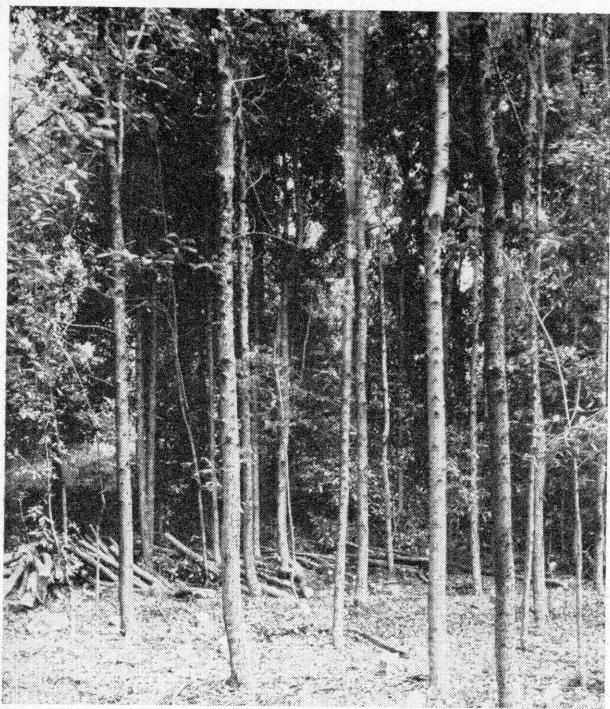
Policies concerning the improvement and management of the forest land resources after acquisition should recognize the need for maximum employment in the area during a period of adjustment of the population to less intensive land use. Developmental work within the forest after acquisition can for a time occupy a large number of local people, but multiple-use forestry will generally not employ permanently as many as were previously employed by destructive agriculture, so new sources of employment for many of them may eventually be necessary. The final objective should be the maintenance of a permanent population within the forest boundaries which can be adequately supported partly from the conservative use of such small areas as are suited to subsistence farming, and partly from work related directly to the forest—its utilization, management, and administration.

Experience of the Puerto Rican and Federal Forest Services to date indicates that from 5 to 10 percent of the blocks of forest land consist of valleys and other relatively level areas that can be used permanently for subsistence farming. Experience has also shown that tracts of 6 acres provide an adequate area for subsistence farming by one family in the forests where such farming is feasible. Thus it is estimated that the area proposed for public acquisition in the next 10 years could provide permanent subsistence farms after acquisition for about 1,250 families. The impact of public land acquisition is, therefore, less real than apparent. Such additional population as exists in the area at the time of acquisition must eventually be accommodated by other sources of employment, either in the vicinity or elsewhere. The establishment of local industries would provide an ideal method for reducing excessive population pressure on the land itself.

Forestry Incentives for Landowners

The Government obviously cannot afford to purchase all forest lands in order to protect them and put them under good management, nor could such management be efficient, because most of these lands are widely scattered in small tracts. Therefore, the private landowner must be relied upon to practice protective and productive forestry on at least 175,000 acres which are in blocks of less than 10,000 acres in size, or about 30 percent of the forest lands. The Government should provide incentives to private forestry, since satisfactory results from education alone may not precede the destruction of the basic soil resource. The rate of private forestry progress will also directly indicate the area of land which the Government must acquire. The more forestry the private landowner practices, the less will be required of the Government.

The value of economic incentives in forestry is seen in the coffee industry, the financial returns from which have been responsible for the preservation of a tree cover on some 200,000 acres of lands not suited to other known types of agriculture and lands which would have been severely eroded if not so protected. The economic incentive of the yield has in this case been sufficient to provide some protection of the resource. In recognition of the absence of other more remunerative protective crops known to be adapted to this region, the public should encourage the continuation of coffee culture in the highlands and should take measures to stop the trend toward abandonment and clearing of coffee plantations. Until a substitute crop appears, incentive payments for the rehabilitation and improvement of existing coffee plantations and the establishment of new plantations should continue to be offered within the region most suited to coffee culture. The preservation of the coffee industry is the cheapest way to protect the steep slopes and the rivers of the coffee region. Incentive payments should be confined to conditions and practices which are certain to improve land use, and should be offered only when careful checking of compliance can be assured. They should be tapered off as rapidly as the returns from higher yields resulting from the use of improved cultural practices enable growers to begin absorbing the additional costs entailed.



Trees can grow as a crop on Puerto Rico's worst soils. This plantation of maria in the Maricao Insular Forest was established on a sterile red clay which had been abandoned by farmers.

Incentives for good forestry practice on private lands should be offered through a comprehensive program of farm land use in which they form a logical part of a general incentive program. Incentives should be in the form of payments for the successful establishment of forest plantations, rather than merely on tree planting, as at present. Half the cost of tree planting should be paid if at least 600 trees per acre remain at the end of the first year. This would approximate \$10 per acre. Half the cost of plantation care should be paid each year for the next 2 years. This would be about \$3 per acre per year.

An indirect incentive which should be continued is the propagation by the Government of the forest trees needed for farm plantings and their distribution to the farmers. The cost of this propagation averages about \$10 per thousand trees. Present nursery facilities are adequate to propagate 10,000,000 trees annually, the maximum foreseeable demand in the near future. Experience elsewhere has shown that best results will be obtained in the long run if the farmers are requested to pay a part, probably half, of the cost of these trees. They should be reimbursed for this cost by the incentive payment received at the end of the

third year if the plantation has been successfully established. The total cost of tree propagation today is about \$20,000. If expanded to 10,000,000 trees annually and supported half by the farmers it would cost \$50,000.

Tax relief or differential rates favoring certain forest practices have not been effective in the past and are not to be recommended at present. Tax rates on forest lands below levels warranted by their productivity tend to prolong apathy concerning their use and care. Nevertheless, such lands are offered for sale at artificially high prices since they do not bear their fair tax burden. Thus an incentive payment program appears to provide a more flexible method of obtaining good land use.

Legislation requiring proper use of forest lands deserves thorough consideration as a supplement to other measures. Although the possibilities of education and incentives have not been fully explored and although the soil conservation district program holds much promise in improving land use, progress along these lines may not be sufficiently rapid to save forest land resources in critical areas before their value is greatly reduced. The proposed public forest-land acquisition program is based upon this belief. The most serious abuse of forests might be stopped by official public recognition of the critical areas as forest areas within which all clear-cutting of any forest or coffee plantation now existing or which develops in the future is prohibited without approval by the Government. If new markets, new forest crops or management techniques provide a strong economic incentive to practice tree culture on those lands, the enforcement of such legislation should be no great problem, and satisfactory progress by private initiative could be made on the best forest lands. If this incentive does not appear, enforcement will prove costlier than public acquisition and this will necessitate an accelerated public acquisition program.

Recreation, Wildlife, Community Forestry

Satisfactory areas for forest recreation are not adequate at present because of the scarcity of forest in suitable locations. Private capital has not been important in the development of such areas, and Government should continue to be the chief participant in order to assure a uniformity of policy and availability of facilities to all.

Forest recreation facilities should be made available near all centers of population. Development should be directed first toward the satisfaction of the forest recreation needs of the local population, and second to the needs of tourists from outside. Picnic areas in the forest have proven to be the best use of this environment to serve a large number of local people. The sale or long-term lease of summer home sites within public forests should be discontinued as it puts the scarce local resources in the hands of a few people and makes them unavailable to the general public.

Reforestation and good forest management will also increase, with no special measures, the beneficial wildlife population. The numbers of certain wildlife species might be increased by encouraging food plants, providing special refuge areas, and other measures. The identification of important wildlife food plants should be undertaken. When a larger public forest area has been blocked out in the central mountains, an effort should be made to introduce the native parrot to this area from the Luquillo Mountains. Hunting

of pigeons and doves within the public forest lands should continue to be prohibited until their numbers have increased to a level adequate for a seasonal hunting period.

In many areas the local forest lands, including those publicly owned, constitute the chief source of forest products for rural communities. Experience in the Cambalache Experimental Forest on the north coast has shown the high value of forest to local communities and the necessity of dedicating such areas primarily to the production of local needs. A survey of all present public forest areas, including an analysis of their present and potential contribution to adjacent communities, should be made as a basis for dedicating more areas as community forests and managing them for the products most needed locally. But the acquisition of lands specifically for community forestry should not be undertaken unless they are acquired also for resource protection, since community forestry is a less pressing problem than is watershed protection.

Chapter VII

Utilizing Grassland Resources

One of the great and most promising potentials for increased production in Puerto Rico lies in the improvement of grasslands to produce pasture, silage, and green crops for livestock feeding. More and better grass can be grown on the island, and ample land suited for this purpose is available. Improved pastures and forage crops on this land would provide the basis for a considerable expansion in livestock production, especially dairying, and thus produce a far greater economic return than is now obtained from these same acres.

Much of the land now used for pastures in Puerto Rico is generally regarded as being low in productivity. Actually, this includes a great deal of land which previously had been cropped but subsequently deteriorated, principally through erosion, to a point where cropping no longer was profitable. This erodible land was then abandoned to volunteer vegetation that was usually low in palatability as well as in yield. Thus, this land came to be used as pastures, and little consideration has been given to its proper utilization and improvement.

Altogether, there now are about 730,000 acres of strictly pasture lands in Puerto Rico, most of which are still in unimproved pastures but possess a considerable productive potential. The productivity of much of this grassland could be doubled and even tripled simply by the use of such pasture improvement practices as liming, fertilizing, re-seeding, and the adoption of better grazing systems and more efficient management of the improved grasses and legumes. With improved grasslands and increased production from pasture, silage, and soilage crops (grasses planted only for cutting and feeding green), Puerto Rico would be in position to save materially on imported feed costs, at the

same time making more effective use of local resources with greater returns to the economy.

Lacking in improved pasture and other grass crops, Puerto Rico now has to import at high cost much of the feed needed for its livestock, especially for dairy cattle. This makes milk production expensive. With good pastures and the use of silage and other forage crops for feeding dairy cattle, milk production on the island could be increased substantially and made far more economical. A good pasture is generally recognized as the lowest cost feed that can be furnished dairy cattle, and use of silage and soilage further reduces feed costs. It has been estimated for the United States that pasture alone furnishes one-third of the feed for dairy cattle at one-seventh of the total cost. The advantage that Puerto Rico has in a longer grazing season will obviously allow cattle to obtain larger proportions of their feed from pastures than in northern latitudes.

In Puerto Rico, pastures are to be found all the way from the low-level lands of the coastal areas to the very steep slopes of the mountainous interior. Of the 730,000 acres now considered as strictly pasture lands, nearly 80 percent constitute cleared land and the remainder is woodland pasture. The cleared pasture lands are distributed among the cropland areas throughout the island. The cleared pasture lands also include about 60,000 acres of fallowland and 97,000 acres of idle land which consist mainly of native grasses in the developmental stages of the vegetation, which are also pastured. About 30,000 acres are also planted to silage and soilage or green-feeding crops.

The most important types of pasture are found largely on the dry uplands and coastal plains which surround the island, although some develop-

mental types occur in the mountainous interior region. The four most extensive areas are the northern coastal plains grasslands, the grasslands of the dry uplands and adjacent plains of the west and southwest, and those of the southern coastal plains and foothills, and the grasslands of the mountainous interior region.

Moisture conditions and topography of the land vary widely in different parts of the island and these factors largely determine the uses now being made of the soil. The present uses, however, may be modified by improved practices and methods of management. This is evident in the situation that now prevails in the use of grasslands in various areas of the island.

Some lowlands near streams, for example, are too wet for the production of cultivated crops. These are used for pasture during the dry season and for the production of grasses to be cut and fed green during the wet season. Para grass (*Panicum purpurascens*) and Carib grass (*Eriochloa polystachya*) are the principal grasses in such areas. These areas are subject to periodic floods during the wet season, and cattle are exposed to foot rot and intestinal parasites if grazed on them during this period.

Some lowlands that have adequate surface drainage but are underlain with heavy clay subsoil are not suitable for most kinds of crops that require intertillage. Cattle are grazed generally on such lands. Although the yield of pasturage is low, the lands will not produce a cultivated crop economically. Such areas generally are occupied by tropical carpetgrass (*Axonopus compressus*) and cintillo or sour paspalum (*Paspalum conjugatum*).

Dry lowlands are found mainly on the south and southwest coasts of the island. Those that are suitable for irrigation are planted to sugarcane. Others are pastured. The yield of forage is comparatively low. The main grasses are paragüita (*Chloris inflata*) and cerrillo (*Sporobolus indicus*). Where the soils are saline, a condition in some instances due perhaps to comparatively recent geological uplift of the lands above sea level, there is still a considerable stand of beachgrass or seashore rush grass (*Sporobolus virginicus*), which is a pioneer grass ecologically and is generally found only a short distance from the seashore. This grass is low in palatability and yield and constitutes poor pasturage.

On the north coast, where the soil is sandy and subject to seasonal droughts, the grass consists mainly of Thalia lovegrass (*Eragrostis ciliaris*), abrojo or southern sandbur (*Cenchrus echinatus*), and Bermuda-grass (*Cynodon dactylon*). The last named species is prevalent in fields that formerly have been in cultivation.

Large areas of sandy soils along the coast are utilized as coconut groves, occasionally in connection with dairy farms. The land among the trees is planted to Para grass and elephant grass or Napiergrass (*Pennisetum purpureum*). The Para grass is grazed and the elephant grass is cut and fed green.

The moist uplands that are used for pasture are found in the northern part of the island, especially in the "haystack" hill region, where the soil originated from calcareous rock and is underlain by it from several inches to a foot or more below the surface. These areas are occupied mainly by St. Augustine grass (*Stenotaphrum secundatum*) and cerrillo.

On the south and the southwest sides of the island are the dry uplands. Where the soil is more than 6 inches deep the main grass is cerrillo. This native grass has been replaced rather generally by planted guineagrass (*Panicum maximum*). Where the soil is shallower it is occupied generally by lamilla (*Bouteloua heterostega*), since guineagrass that is planted on such shallow soils is subjected to being pulled up by the roots by grazing animals.

On the croplands which are distributed throughout the island, pastures and grasses play a minor economic role. Where one of the main sources of income is from dairying, some farmers rotate croplands with pastures. Such pasture areas are planted to Carib grass and Para grass in the northeastern part of the island, and to guineagrass in the region west and south of Arecibo. More frequently, however, croplands are abandoned when they no longer are productive and are allowed to grow to volunteer grasses consisting of such annuals as jungle-rice (*Echinochloa colonum*) and Jamaica fingergrass or pata de gallina fina (*Digitaria horizontalis*), also called pendejuelo, locally, which is the name for *Paspalum decumbens*, on the north side of the island, and redtop millet (*Panicum adspersum*) and paragüita in the dry region on the south side. These grasses are followed by others in succession de-



A poorly managed pasture yields very little for cattle to eat.

pending upon the length of the time the land remains idle. Frequently there is a thick stand of Bermuda-grass immediately following abandonment.

In addition to the cropland pastures there are almost 150,000 acres of woodland pastures. These are located primarily on slopes on the south side of the divide that are too steep for cultivation, in the open savanna lands between the seacoast and the foothills, and in the coffee region in the west central part of the island. The number of trees per unit area is decidedly variable and ranges from a few to many trees per acre. The native grasses in these pastures on the steep slopes on the south side of the divide comprise mainly cerrillo, which is distributed throughout the area, and, at the higher elevations, sporadic or, in some places, thick stands of zorra or silky grass (*Trichachne insularis*). At the lower elevations south and west of the divide, lamilla is the predominating native grass. The main grasses in the savanna lands between the foothills and the coast

in the vicinity of Ponce and Salinas are seashore rush grass, cerrillo, Yerba de Salinas or buffel grass (*Pennisetum ciliare*), and paragüita. Many of the woodland pastures south of the divide have been improved by planting guineagrass. In the coffee region of the west central and north central parts of the island the principal woodland pasture grasses are tropical carpetgrass, cerrillo, and St. Augustine grass.

Land for Pasture and Forage

Although about 730,000 acres are now regarded as being grasslands because of their present use or condition, this does not mean that all these acres are being employed for the purpose to which they may be best suited. Undoubtedly, some of this land with very steep slopes would be far better utilized if planted to forest or some tree crop. On the other hand, there is no doubt that much land on the island is being used for intertilled crops when it might be used more advantageously if devoted to improved pasture. All of this merely

points up the need for better use of the land according to land capability.

By far the best classification of land according to capability has been worked out by the Soil Conservation Service. This classification consists of eight categories, ranging from class I which is land best suited for continuous cultivation to class VIII which is land suited for recreation or wild-life.

Most of the land in Puerto Rico is on slopes and the degree of slope is one of the factors affecting land capability, even for pasture. Most of the steepest sloping land is in class VII and this class of land is normally questionable for pasture because of extreme hazards of slope, shallow soil, local arid soil climate, and other factors. Some class VI land may also be questionable for pasture except on a very extensive and rather unprofitable basis. Class V land is wet land which is suitable for pasture or cut forage but not for cultivation. All other classes, i. e., I, II, III, and IV, can be cultivated following conservation methods of farming, including forage crops and pastures in a well-balanced crop rotation.

Strictly from the standpoint of the capability of land for continuous production, research studies and detailed observations on many parts of the island indicate that a 50-percent slope is close to the upper limit which should be considered for pasture, even under good grazing management. Mechanical erosion is the primary factor which

precludes effective, continuous use of land for pasture on any steeper slopes. In order to use land with a slope as steep as 50 percent for pasture, the plant coverage must be excellent. With good herbage protection 50 percent should be considered as the upper slope limit, and 40 percent slope should be the upper limit on land which will support only moderate herbage density, such as on shallow soils.

Out of the island's total of 2,184,591 acres of land, it is estimated that 664,000 acres are best suited for the production of pasture and forage crops (table 32). If there is any great difference between what is needed and that which exists as pasture, it is not in acreage but in the quantity and quality of the pasture and forage produced. Proper management and balanced stocking also, of course, are essential to good pasture.

In general, pastures in Puerto Rico are of low productivity because of the little attention that is given to grazing systems, use of legumes, reseeding, application of lime and fertilizers, improved pasture practices and management, and to research for the improvement of the existing species. Other factors, such as the seasonal lack of water in certain pastoral regions of the island and the need for supplemental feeding, contribute to the poor condition of native pastures.

In many parts of the island, lands used for pasture are badly eroded, and the process of erosion continues because of the inadequacy of the grass

Table 32.—Estimated desirable acreages of pasture relative to land class ¹

Land class	Total acreage	Approximate percentage best suited to pasture	Approximate acreage best suited to pasture	Primary reasons for using as pasture or forage
I.....	56, 068	Very small....	Very small....	To control erosion and improve soil for cultivated crops, and to balance the feed supply for farm plans.
II.....	181, 204	20.....	36,000.....	
III.....	366, 283	30.....	110, 000.....	
IV.....	91, 683	50.....	46, 000.....	
V.....	69, 293	90.....	62, 000.....	Too wet for other crops. Most profitable use which will control soil movement. Most of class VII needs woodland protection.
VI.....	460, 574	70.....	322, 000.....	
VII.....	882, 328	10.....	88, 000.....	
VIII.....	23, 424	
Miscellaneous (lakes, roads, urban areas).	53, 734	
Total.....	² 2, 184, 591	664, 000.....	

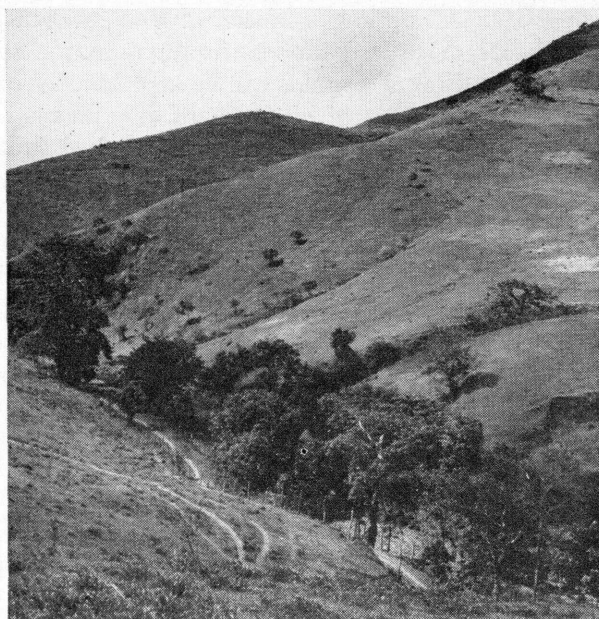
¹ Based on data from Soil Conservation Service, U. S. Department of Agriculture.

² Total land area as determined by a survey made by the Puerto Rico Planning Board.

cover. Erosion and excessive runoff from grasslands can usually be controlled by careful grazing management alone, but high, profitable returns per acre normally require attention to forage species, soil treatment, and control of weeds and trees, as well as to grazing management. By considering these several aspects of pasture improvement and use, it becomes feasible to prevent overgrazing and land deterioration without reduction of present livestock numbers. High forage production on suitable land thus not only protects the specific land areas themselves, but it also makes possible a considerable adjustment in cropping and a reduction in the intensity of use of land now being cultivated in excess of its capability for sustained production.

So long as there are thousands of acres of unimproved grassland well suited to pasturing and improvement in Puerto Rico, there is little point to spending time and money for pasture improvement work on lands approaching the limits of soil and slope suitable for pasture. It is more practical to put such steeply sloping lands into woodland, or some tree crop such as coffee, where growing conditions are suitable. Experience in other areas has been that as pastures and animals both improve, it becomes evident that lands over 40 percent in slope are too steep and too difficult to maintain in pasture for farmers to continue trying to use them for grazing. Proper management and improvement of land well suited to pasturing with improved animals have shown that it pays best to concentrate even more on the adapted land rather than to develop or improve land that is marginal for pasture use. But regardless of the possibility that pasture land may become more restricted in the future, there certainly is every reason to emphasize forage improvement on the better land first.

Much of the forage improvement should be on land that will be cropped part of the time, but not used exclusively for pasture, that is, as forage in sequence with cultivated crops on land classes II, III, and IV. This is done on a large scale now, especially on class VI and class IV land, except that the period in forage is essentially a case of abandonment of the land for a period of from one to several years. Planned, well managed sequences involving high yielding legumes and grasses instead of inferior native species, would provide a valuable return from the land at the



This sloping land was abandoned after having been exhausted by clean tillage and continuous cropping. Establishment of an improved pasture would make such land valuable for grazing livestock.

same time that it was being more rapidly improved for the next cultivated crop or crops. In such a pattern pasture could be produced to good advantage under irrigation also. In many parts of the island, however, there is a great need to establish grass on land so that a protective cover may be provided as a first step in restoring productivity. In the mountain areas there is a high percentage of sloping land that has been ruined for further use because sugarcane or other tilled crops have been planted where only permanent pastures or permanent forests should be located. This great and costly damage could have been avoided at the outset if, in planning the use of the land, recognition had been given to the factors of slope, plant cover, soil, and degree of erosion which are embodied in the land classification developed by the Soil Conservation Service.

Pasture Improvement With Legumes

The grasslands of Puerto Rico represent a vast underdeveloped resource which through wise handling and use can add greatly to the health and welfare of the people. The value of these grasslands lies in the nutrients they are capable of producing for feeding livestock from which milk, meat, and other products are derived for human consumption. However, most of the grasslands on

the island are now low producers of feed nutrients. Therefore, more acres are required to maintain an animal, and fewer animals can be kept because of the limited amount of land. Also, this makes it necessary to import large quantities of feedstuffs which are far more costly for feeding than are locally produced supplies.

Too few farmers are aware of the fact that Puerto Rico can produce considerably more feed nutrients per acre of grassland than is now the case. This is true even among the few farmers who have well-managed grass pastures. The key to boosting the production of feed nutrients from grassland is in the use of legumes, and their proper use along with other necessary improvements will increase livestock feeding values of present grass pastures in Puerto Rico by three or more times. The fact is that grass and legumes will produce on much of the croplands more total digestible nutrients per acre at lower costs, and with greater returns per man hour of labor, than will corn or the other feed grains.

No legumes are now planted primarily for pasturage in Puerto Rico. The planting of combinations of grasses and legumes for pasture is relatively uncommon on the island. It is a well-established fact that a legume increases the protein content of the grass with which it grows in combination; it also increases soil fertility by the nitrogen in the high protein residue and the nitrogen formed in the nodules of the legume roots. Moreover, legumes increase the resistance of pastures to the effect of water erosion, and add variety, longevity, and palatability to the grazing.

In the pastures of Puerto Rico there are, however, a considerable number of native species of legumes which are found in permanent pastures, on hillsides, and in thickets at lower and middle elevations. But the amount of forage they yield is comparatively low because of the competition with existing vegetation and the effects of continuous overgrazing.

Among the more common native species of legumes that are eaten by livestock are flor de conchitas (*Bradburya pubescens*), zarzabacoa enana or "wild alfalfa" (*Stylosanthes hamata*), various species of pega pega (*Meibomia supina*, *M. adscendens*, *M. purpurea*), habichuela cimarrona (*Phaseolus adenanthus*), wild cowpea (*Vigna vexillata*), frijolillo (*Dolicholus reticulatus*), moriví bobó (*Aeschynomene americana*), zarzaba-

coa de tres flores (*Sagotia triflora*), and yerba de contrabando (*Alysicarpus vaginalis*).

One of the most widely distributed legumes throughout the island is the conchita. A dense stand of this legume, frequently covering as much as 50 percent of the soil, is found in planted guineagrass pastures on both the southern and northern coasts of the island. Cattle eat the green flor de conchitas leaves, but not with relish, so that the vines have an opportunity to creep along the ground and climb over the guineagrass bunches.

By far one of the most common legumes in the pastures of the limestone areas is "wild alfalfa." It grows abundantly in pastures of lamilla in the south and southwest, and in cerrillo and paragiita pastures of the northern coast, especially in soils of the Colinas and Tanama series. It grows to a height of 6 to 12 inches and is generally grazed to a height of about 2 inches from the ground. Because of the deep root system, this legume can obtain water at deeper levels than the grasses with which it grows in association, and thus is resistant to drouth.

Further studies should be made on wild alfalfa to determine its nutritive value, nodulation, propagation, etc., inasmuch as promising native legumes that are already adapted to certain environmental conditions in Puerto Rico should have a prominent place in a program of pasture improvement.

The species of *Meibomia* known as pega pega are very common in pastures of St. Augustine grass along the northern coastal plains. As many as 125 plants of zarzabacoa común (*Meibomia supina*) have been counted in a single square meter of St. Augustine pasture. The species of pega pega are among the most highly palatable of native pasture legumes. They require a comparatively moist, fertile soil that has good subsurface drainage.

Another native legume, *Alysicarpus vaginalis*, occurs abundantly in pastures of St. Augustine and carpetgrass. It grows in association with the various species of pega pega and is also relished by livestock.

The average protein content of the forage fed to livestock may be improved also by establishing on the pastures a number of leguminous shrubs or trees. The tender growth as well as the pods

of these leguminous forbs and trees are relatively rich in protein.

Among the leguminous trees that are found in pastures of the southwestern part of Puerto Rico is the bayahonda, or mesquite (*Neltuma juliflora*). The stock browse on the young shoots, which are high in protein. The pods and beans of this tree are also relished by cattle and make a good concentrate feed.

Other leguminous trees that are planted in pastures are the bucayo enano (*Erythrina berteiroana*), woman's tongue (*Albizzia Lebbek*), and the shrub, *Leucaena glauca*, or acacia. Some farmers cut these trees periodically so as to encourage a low, new growth that can be easily reached by livestock. The new growth can also be fed as soilage. In addition to the value of the foliage and pods for forage, these leguminous trees may be used as windbreak hedges and for shade.

There has long been a great need on the island for vigorous leguminous plants that could be used for grazing. During the 1940's, several legumes were introduced. The most promising of these are tropical kudzu (*Pueraria phaseoloides*) and trailing indigo (*Indigofera endecaphylla*), both introduced by the Soil Conservation Service.

Tropical kudzu is a vigorous, spreading perennial which is adapted to the moist coastal plains and uplands of the island. The foliage contains from 20 to 22 percent protein (dry basis). It is palatable and yields from 20 to 24 tons of forage per acre annually. This legume is a valuable perennial for many regions of the island.

Extensive trials with tropical kudzu made by the Soil Conservation Service and the Bureau of Plant Industry, Soils, and Agricultural Engineering in cooperation with the Puerto Rican and Federal experimental stations indicate the value of this legume. Trials made at Orocovis, Mayagüez, and other regions in Puerto Rico have shown that tropical kudzu with molassesgrass is at present the best combination to produce good returns in beef per acre in the mountain area. At Orocovis, the cattle showed a rate of gain of 1.5 pounds per day per head, and a return of 477 pounds of beef per acre. This return represented around \$95 per acre for the farmer. No supplementary feed and little labor were needed. It took only \$20 per acre to get the pastures started. The net return amounted to \$75 per acre the first year,



Tropical kudzu and molassesgrass planted in combination makes a luxuriant pasture under growing conditions such as those that prevail in the Orocovis area. This planting is on steep, shallow, eroded Mucara clay—soil that is typical of large sections of the island.

and this was from land that is too steep for cultivation.

It is estimated that grass pasture in the Orocovis area, without tropical kudzu, may produce about 180 pounds of beef per acre at a rate of gain of 0.7 pound per head per day, while the results of the trials with tropical kudzu were 477 pounds of beef at 1.5 pounds per head per day. At Mayagüez similar gains were obtained from Guernsey heifers on kudzu with grass, the rate of gain being 1.7 pounds per head per day. Milk cows produced about 2 pounds more milk per head per day on the good grass-legume pasture than on good barn feeding alone. This happened 2 years in succes-

sion. The value of the increase represents about \$40 profit per cow per year.

Recent experiments conducted at the Puerto Rican Experiment Station indicate that a mixture of tropical kudzu and guineagrass or Para grass increases both the total yield and total protein content of the grasses. The combination of Para grass and kudzu was found to give the best results in total digestible nutrients, gain in weight of the animals, and carrying capacity of the grass. Kudzu alone contained 17 percent crude protein on the dry basis, and Para grass in the mixture had a higher protein content than when grown alone.

There are five important grasses in Puerto Rico that grow well with kudzu, the specific combination varying with local conditions. These grasses are Merker, elephant, molasses, malojillo or Para grass, and guineagrass. Combinations involving more than one grass help provide a better balanced production throughout the year than with a single species.

Molassesgrass and kudzu form a natural combination for the mountainous region. Both species thrive on about the same height of grazing or cutting.

Malojillo or Para grass has formed an excellent pasture with kudzu at Mayagüez for more than 5 years on river bottom soil. Malojillo and kudzu are also growing well at Río Piedras, at Orocovis, and elsewhere.

Guineagrass and kudzu are growing well in humid parts of the island such as in Mayagüez, Río Piedras, and Orocovis.

Merker grass and kudzu have been grown in combination at the Puerto Rican Experiment Station in Río Piedras, at Mayagüez, Utuado, Orocovis, and Barranquitas. More information is needed, however, on the management practices of this combination.

Although much research is still needed to determine the best combinations of grasses and legumes for both pasture and cutting in each of the ecological regions of the island, some indications are already apparent on the basis of observation and incomplete research.

On the northern coastal plains, it appears that Para grass and kudzu should be planted in wet lowlands and guineagrass and kudzu on wet uplands. Merker grass and kudzu should be used as soilage.

On the drier uplands of the northern coastal plains guineagrass and trailing indigo appear to make a good combination although the latter is toxic to livestock. Among the native grasses *cerillo* and the native legume, wild alfalfa, will do well on hilltops while St. Augustine and wild alfalfa will thrive on the foothills.

For the southern coastal plains the best native legume appears to be wild alfalfa, which will grow very well with lamilla and buffel grass on the uplands that are not irrigated, and on the unirrigated level lands guineagrass and wild alfalfa. Irrigated lands can be planted to Merker and kudzu, while Para grass and kudzu will do well in the wet lowlands.

For the mountainous region the best combination so far is molassesgrass and kudzu.

Other species of introduced and native legumes and grasses should be tried more extensively in each one of the areas.

Some of the climax grasses that constitute permanent native pastures on the island are of low yield and of comparative low nutritive value. A typical example is the lamilla grass which predominates over thousands of acres of arid, shallow, stony soils of the west and southwest. Steps should be taken to replace these inferior species with introduced varieties and species of superior forage value.

Among the introduced species that should be tested in the various ecological regions of the island are the pangola grass (*Digitaria decumbens*), Barbados sourgrass (*Andropogon pertusus* var. *acidula*), Giant St. Augustine grass, Bahía grass (*Paspalum notatum*), Yaraguá (*Hyparrhenia rufa*), and others.

Recent evaluation studies on new varieties of grasses have shown that Hybrid #208 x #1 gave higher yields than Merker grass. At Isabela the yield of this hybrid was 77 tons of green forage per acre per year, while at Lajas the annual yield was 60 tons. Merker grass produced 70 and 53 tons of green forage at Isabela and Lajas respectively.

From the standpoint of the farmer it is important that the proper kind and quality of seed needed for pasture and forage crop improvement be readily available. Local sources of seed production need to be encouraged in order to assure adequate supplies of the good seeds that will be required for more effective use of grassland re-

sources. Efforts should be made to stimulate farmers and other private operators to produce good quality seeds for sale on the island.

However, until such time as private production is increased to meet requirements, the bulk of the improved grass and legume seeds needed should be produced on the seed farms operated by the Puerto Rican Government. These farms should produce certified seed of superior quality, and of the grasses and legumes found by research workers to be adapted to conditions in Puerto Rico. In order to protect the interest of farmers, a system of seed testing and inspection should be established so that any seed bought will be of known quality and purity.

Use of Pasture Supplements

Although good pasture is the most economical feed for livestock, it is not available throughout the year in many sections of Puerto Rico. Therefore, there is often a need for pasture supplements. At present, most farmers on the island make use of various pasture supplements and these fall roughly into eight classifications: (1) Grasses planted only for cutting and feeding green; (2) grasses planted for cutting and feeding green and for pasturage; (3) grasses planted for cutting and feeding green and for grain; (4) grasses not planted but cut and fed green; (5) sugarcane tops; (6) silage; (7) hay; and (8) feed concentrates.

Three main grasses are planted only for cutting and feeding green in Puerto Rico. These so-called soilage grasses are Merker grass, elephant grass, and Guatemala grass. All of these require for their best growth a fairly fertile soil with abundant rainfall. However, in certain parts of the island, especially in the region near Arecibo, farmers plant Merker and elephant grass in sandy soils of low fertility. The soils are first fertilized with heavy applications of filter-press cake, a residue from the sugar mills, and the grasses grow luxuriantly on such treated soils. These soilage grasses can be cut from four to six times a year, depending upon the stage of maturity at which they are fed. On large farms the soilage is run through an ensilage cutter before feeding, while on small farms near Arecibo the grass is cut and the entire stem and leaves are given to livestock in the same field. This is done by tethering the animals close to the cutting area, where they can reach the cut bundles

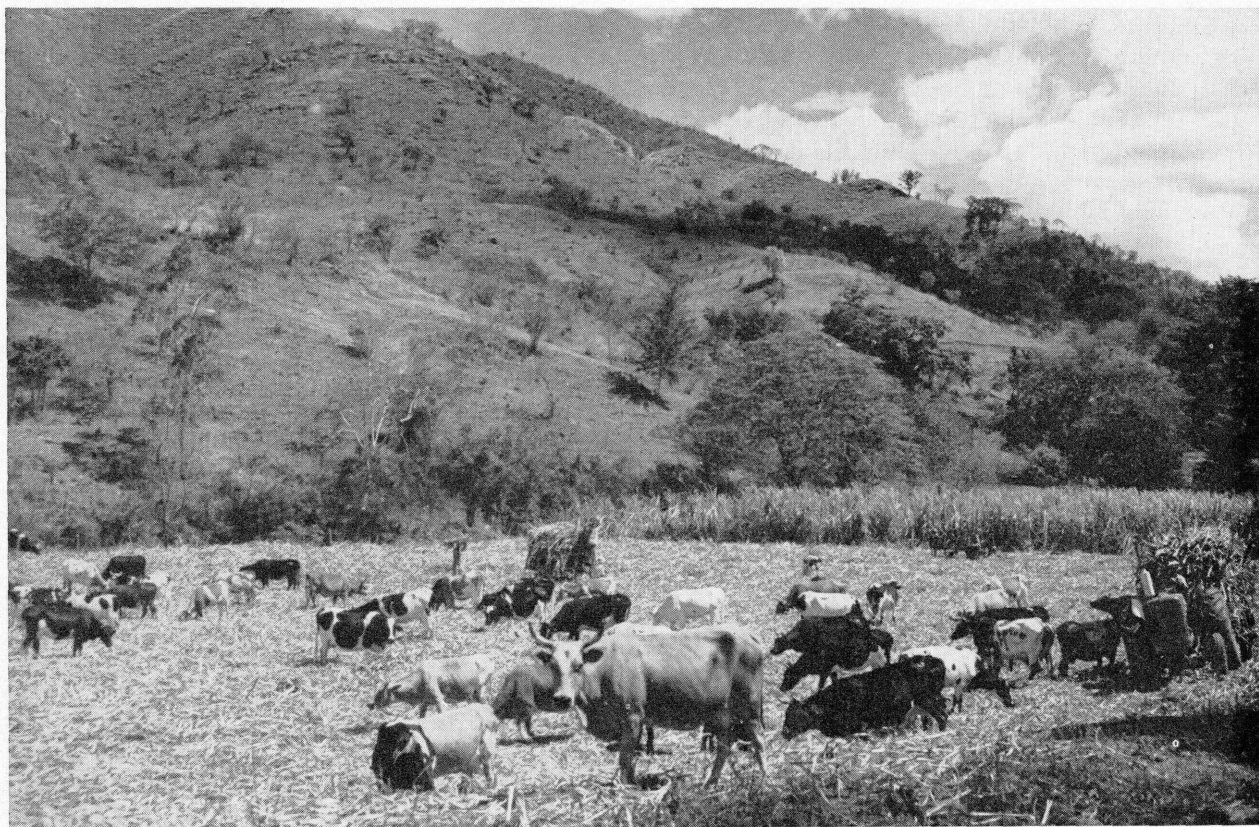
of grass. As much as 70 tons of soilage may be obtained from Merker and elephant grasses per acre per year. None of these grasses withstand continuous grazing or trampling.

There are three important species of grasses planted for cutting and feeding green and for pasturage. They are guineagrass, Carib grass, and Para grass. They are used for feeding pack animals, oxen and beef animals, and dairy cows. Guineagrass is planted on the dry uplands and on coastal plains with good drainage, while Para and Carib grasses are planted on poorly drained lowlands. Some dairies near San Juan, Mayagüez, and other large cities, depend almost entirely on these grasses as their source of forage.

Two species of grasses are planted for cutting and for feeding green and for grain. These are Indian corn (*Zea mays*) and Guinea corn or sorgho (*Sorghum vulgare*). Indian corn is most common, and it is planted for grain throughout the island. The fodder is fed directly to livestock. On the dry south side, however, it is planted on a few dairy farms, to be fed as silage. The estimated yield of green forage is 7 tons per acre per crop.

Grasses not planted but cut and fed green include the many species which may be found growing along roadsides or in idle areas. These grasses are used by the many people in rural and urban areas who do not have lands, but who keep a few goats or a cow. These people cannot afford to buy feed; so they search for grasses to be cut and carried home. The most desirable kinds are Carib and Para grasses that grow near swampy areas, or guineagrass and gramalote that grow in ungrazed abandoned fields intended for planting sugarcane. If these are not available, these people use goosegrass (*Eleusine indica*), gramalote, pen-dejuelo, or other annuals that are available. Sometimes, especially during prolonged droughts, the short branches of bamboo and of Indian grass are cut and their leaves fed to cattle.

Sugarcane tops are used during the harvest season in different parts of the island, especially for oxen. Many dairies, especially in the drier regions, depend almost entirely on sugarcane tops as a source of forage during the cane harvesting season. This season usually coincides with the season of severe drought in the south and southwest of the island.



When the prolonged dry season starts in the southern part of Puerto Rico farmers soon find themselves short of feed and are forced to use sugarcane tops for their cattle.

Most of the silage is used in a small area near Coamo, Salinas, and Ponce. Some is used along the northern coast. A few farmers in other areas, such as near Lajas and Cabo Rojo, are also becoming interested in feeding silage, and some silos have been built. But progress in the use of silage has been very slow despite the fact that this feeding supplement could be utilized very profitably in most parts of Puerto Rico throughout the year. In 1940, there were only about a dozen silos in active use, while in 1951 there were between 50 and 60 silos in operation throughout the island. Actually, only about 20 farmers operate silos on their farms in the drier section from Guayama to Cabo Rojo.

The greatest need for the kind of supplementary feed that silage can provide happens to be in the most important dairy regions, where prolonged seasonal droughts occur every year and result in the biggest losses to the livestock industry. From February to May the northern section of the island is relatively dry, while this period extends

from February to July along the south and southwest. Pastures are poor during these dry spells, and silage could do much to help meet the need for feed and at the same time make feeding more profitable.

The number of silos used is unquestionably inadequate to furnish the necessary supplementary feeding in the form of silage. Farmers need to be given every possible assistance and encouragement in order to stimulate more widespread use of silage in all sections of the island. In addition to awakening them to the advantages of silage by educational means, steps should be taken to help farmers finance the cost of constructing the necessary facility for storing silage. Loans for this purpose should be furnished by public and private credit agencies, since the construction of a silo and the use of silage represent an investment that will pay off by increasing production and by savings in feed costs. Each farmer in the dry region, for example, should own and operate a silo of 120 tons capacity for each 50 cows. This will provide

enough silage for 120 days, which is enough to last through the most critical period of the dry spells, when pastures are almost completely unproductive. In the wet areas, as well as in the dry sections, silage could be fed advantageously throughout the year. The use of silos all year would promote more intensive land use and add to the supply of feed available for livestock. The grasses best adapted for silage in Puerto Rico are Indian corn, sorghum, Merker grass, elephant grass, and sugarcane tops. Since molasses from the production of sugar is readily available on the island, its use in silage would increase the feeding value of the product. Although pit, tower, and trench silos are used in Puerto Rico, the pit silo appears to be the more convenient and economical type to use in many localities. Tower silos are better adapted to the more humid areas.

The amount of hay made in Puerto Rico is negligible. The most favorable conditions for haymaking are in the dry south and southwest, and probably some may be produced in the northwest, near Isabela. Facilities for storing hay are not available on the island, and there are few grasses that are suitable for hay. Guineagrass occasionally has been made into hay on sugarcane plantations on the south side of the island. The yield of the first cutting is from 1 to 2 tons of hay per acre. It is estimated that the average annual yield would be from 4 to 6 tons per acre. It is relished especially by horses and could be used more extensively.

Alfalfa (*Medicago sativa*) has been tested at the Isabela Substation, and this legume thrived under the environmental conditions there. Nine cuttings yielded 9 tons of dry hay per acre per year. It may be worthwhile to continue testing adapted varieties of alfalfa for haymaking. Other grasses that should be tested for haymaking are Natal grass (*Tricholaena repens*), fine-leaved guineagrass, commonly known as Borinquen variety, star grass (*Cynodon plectostachyum*), Pangola grass, and Venezuela grass (*Paspalum fasciculatum*).

Concentrates fed to livestock in Puerto Rico consist mostly of imported mixed feeds. The biggest portion of the supply of concentrates is fed to dairy cattle, some to poultry, and a small amount to other classes of livestock. Feed imports now approximate 100,000 tons a year, compared with 60,000 tons a decade ago. Most of the feed

imported is in the form of mixed feed and corn. A limited amount of corn and sorghum is produced on the island and fed on the farms. Molasses is also fed to dairy animals, and a few farmers feed the roots of cassava and sweet potatoes.

Feed production could be increased substantially through the use of improved seed corn and improved methods of growing corn, and through the utilization of processing plant wastes and other materials suitable for making byproduct feeds. At the present time, for example, practically all of the peel and pulp from the pineapple canning plants is being wasted. Also wasted are large quantities of blood and other materials from slaughtered livestock. If processing facilities were available all of these and other plant wastes could be converted into economical feeds.

More widespread use of legumes for pasture and forage would increase the protein available to livestock, thus making it possible to reduce protein-feed imports. A concentrate mixture containing 14 to 16 percent total protein should be adequate to supplement improved pastures and silage and silage crops. Since high-protein feeds are more expensive than feeds rich in carbohydrates, a considerable saving in the feed bill would be possible by using concentrate mixtures of a lower protein content with improved pastures and forage containing legumes.

Many of the soils in Puerto Rico are deficient in minerals needed for building strong bones in animals. Much of this deficiency is due to the great amount of erosion and depletion that has taken place by cropping without regard to conservation. The poor bone structure and small skeletons of many of the animals on the island indicate the need for minerals. This deficiency needs to be met in order to produce larger and more vigorous animals, and to make more efficient use of the pasture, forage, and other feedstuffs they consume. While some farmers on the island are using mineral supplements for livestock feeding, more extensive use of the bone-building elements should be encouraged.

Grasslands Management

The general low level of productivity that prevails on the grasslands of Puerto Rico is due primarily to the lack of proper management of this potentially great resource. Very little attention

has been given to management practices and grazing methods that will increase and maintain pasture and forage yields on a sustained basis.

Although farmers are accustomed to the use of fertilizers on such crops as sugarcane and tobacco, they seldom fertilize or apply lime to their grasslands. While there is some appreciation of the value of fertilizing soilage crops, virtually no attempts is made to improve pastures by the use of fertilizers, even though most of the soils in Puerto Rico are deficient or low in availability of one or more of the nutrients essential for pasture grasses or legumes. In the humid, mountainous sections, grassland soils are often deficient in calcium, phosphorus, nitrogen, and some in potassium. All of these elements are essential for proper plant growth and to improve the mineral content and quality of the forage.

Production from grasslands in Puerto Rico could be increased very substantially by the use of fertilizer. This would greatly boost the amount of feed obtained per acre of land and make livestock production more profitable. Improved pastures require more fertilizer than do natural pastures, but they can be made far more productive. Assuming an attainment of 500,000 acres of improved pastures on the island, farmers will have to use at least 150,000 tons of complete fertilizer per year. The general formula recommended is 10:10:5 to be applied at the rate of 600 pounds per acre in one or two applications. Where a legume is used no nitrogen is necessary. If the acreage devoted to forage crops is increased, as it should be, by about 75,000 acres, an additional 22,500 tons of fertilizer will be required, in addition to about 8,000 tons of ammonium sulphate. The amount of fertilizer to be applied per acre varies, of course, with the particular requirements of the grass and soil involved.

Fertilizer studies made by the Puerto Rican Experiment Station on various forage grasses such as Merker, Para, and guineagrass show that nitrogen applications greatly increase the yield and protein content of these plants. Single applications of 200 pounds of ammonium sulphate per acre resulted in a maximum production of protein and of dry forage in both guineagrass and Merker grass. Para grass, however, gave maximum yields when the same amount of nitrogen was split into two applications, the first one 6 weeks after cutting and the second 9 weeks later. The grasses

all showed a higher nitrogen content when they received the fertilizer in two applications and were cut at 10-week intervals. A lower nitrogen content resulted when the nitrogen was given in one application and the grasses were cut at 12-week intervals.

Lime also is required for increased production from the grasslands of Puerto Rico. To improve 500,000 acres of pasture, it is estimated that a minimum of 500,000 tons of lime will be required every 2 or 3 years. This figure may run to a maximum of around a million tons of lime.

Experiments recently conducted by the Puerto Rican Experiment Station on the effect of lime and fertilizer on the mineral composition of the soil, of the grass, and on crop yield showed, among others, the following results; (1) Liming definitely helped increase yields; (2) applications of 500 pounds of ammonium sulphate per acre gave about 2 tons more of green grass per acre than a previous unfertilized crop; (3) grass harvested early (36 days after nitrogen application) contained around 11 percent protein, or three times as much as in the unfertilized grass; (4) lime was still effective in keeping the soil but slightly acid 32 and 39 months after it was applied. The experiments also showed that lime was effective in increasing the availability of phosphorus and other elements in the soil needed for good pasture.

Crushed limestone for liming soils is sold to farmers in Puerto Rico at a reasonable price from quarries and crushing facilities operated by the local Department of Agriculture. However, only those farmers located relatively near the quarries are benefited, inasmuch as transportation costs make the lime too expensive for farmers over 50 miles away from a quarry. The number of quarries operated by the Puerto Rican Government should be increased from the present 4 to a minimum of 10 well distributed over the island. This would considerably reduce the expense of transportation and stimulate more widespread use of the lime for pasture improvement.

The aim in pasture management is to obtain and maintain the greatest possible production of livestock (milk, meat). This necessitates use of such grazing methods and rate of stocking as will permit the plants to make enough top and root growth to maintain their vigor. In Puerto Rico, continuous overgrazing is a common practice. This has resulted in pasture deterioration



Grasses planted only for cutting and feeding green yield well in Puerto Rico. Merker grass is one of the favorites.

where the prevailing plants are of very low grazing value. Being more palatable, the most desirable pasture plants are eagerly sought by grazing animals. On the other hand, the objectionable, or weedy species, are left over to grow and reproduce. Most of the plant growth in these areas consists of undesirable annuals and perennial weeds. Sheet and gully erosion prevail in most of the overstocked pastures, especially on the highlands. The result is a sharp decline in forage, underfed and underdeveloped stock with a decrease in animal production, and low financial returns and frequent losses.

A local method of grazing that is practiced to a limited extent in the region from Aguadilla to Arecibo, and in the mountainous area, is the "tethering method." In this region farmers with a comparatively small number of animals tether their dairy cows on guineagrass and gramalote pastures, while the dry cows and young stock are tethered on the common pastures of cerrillo,

St. Augustine grass, and carpetgrass. Cattle are staked out with freedom to graze within a radius varying from 15 to 25 feet. The stakes are moved to immediately adjacent ungrazed areas from three to four times a day. When the entire pasture area is thus utilized, usually after four to six weeks, the animals are returned to the first area, where the new growth is ready for grazing.

Purely from the standpoint of utilization, tethering is the ideal method of grazing. However, it has various disadvantages. Where a large number of animals are involved, the method is laborious. Besides, cattle are not free to seek protection from the inclemencies of the weather while pasturing.

Various improved systems of grazing have been developed which should be employed in Puerto Rico. These systems, varying with the particular pasture type and with the region, are rotational grazing, deferred and rotational grazing combined, and the Hohenheim system.

Rotational grazing involves the division of the pasture into a convenient number of units. The livestock are concentrated on one unit while the rest of the pasture is allowed to recover. A good pasture, with the proper grass-legume combination, should be divided into four to six units. Experiments show that this system increases the yield of total digestible nutrients, the number of days grazing, and the production of milk. Furthermore, this system encourages more uniform grazing of the pasture area, thus keeping a proper balance between legumes and grasses, and helping to control weeds. Tests of rotational grazing have shown similar benefits in Puerto Rico. The practice brought not only higher returns per animal and per acre, but it also enriched the land by conservation of both moisture and soil. After a year's pasturing of kudzu-molassesgrass at Orocovis, an average production of 540 pounds of beef per acre was obtained with rotational grazing as compared to 385 pounds of beef per acre with continuous grazing. This is only an indication of what may be expected, and does not account for the condition in which the pastures remained. Rotational grazing left a much better balanced combination of forage plants at the end of the year than did continuous pasturing. Rotational grazing is suitable for all types of pastures and should be practiced throughout the island.

Deferred and rotational grazing combined is a system similar to rotational grazing except that one pasture unit is allowed to reseed each year and recover its natural stand. Under this system, grazing in one pasture unit is delayed until past the blooming season, giving the pasture a chance to reseed and develop new seedlings. It is used mostly in pastures that are propagated by means of seed instead of stolons and rhizomes. This system should be practiced in Puerto Rico in pastures where the dominant grasses are one of the following species: Lamilla, guineagrass, molassesgrass (*Melinis minutiflora*), cerrillo, gramelotillo (*Paspalum plicatulum*), buffel, paragüita, and Natal grass.

Under the Hohenheim system, the pastures are divided into a number of units of equal size and the herd is separated into three groups: best producers, low producers, and calves and bulls. The animals are rotated so that the most productive cows will be turned on first, leaving the other two groups to clean up the pasture. By the time the

first pasture greens up again the fresh cows are back. Applications are made of large quantities of complete fertilizers with heavy applications of nitrogen, usually twice a year. Droppings are scattered by machinery to avoid uneven grazing.

Experiments conducted at Massachusetts showed that the Hohenheim system increased grazing capacity three times, and milk production also was about three times greater. This system, however, can only be used where rainfall is abundant and well distributed throughout the year and in areas close to large cities where the land is expensive. It may be adapted for use with guineagrass in the northern and northeastern parts of Puerto Rico, and with molassesgrass-kudzu in the mountainous region.

To increase and maintain the productivity of pastures it is also necessary to employ practices that will conserve soil and moisture. Steps should be taken to maintain the productivity of the soil by saving it from erosion through a proper adjustment between pasture acreage and cultivated crop acreage as well as between the available pasturage and the number of head of livestock that can be kept on a farm.

Through its Agricultural Conservation Program the United States Department of Agriculture is directly assisting farmers in adopting improved pasture management practices in Puerto Rico. During 1950 this agency had 9,645 farms participating in pasture improvement work that was conducted on more than 47,000 acres of land. As an incentive for their participation farmers received payments totaling slightly more than \$140,000 which helped pay part of the cost of employing such pasture improvement practices as liming, fertilizing, mowing weeds, cutting brush, and establishing permanent pastures. This is a type of activity that deserves to be extended in order to permit more widespread participation.

A general grasslands improvement program which includes planting and proper management practices is necessary to conserve the soil. Old pastures should be renovated by reseeding with the proper balance of grasses and legumes. Likewise, water should always be conserved for livestock and forage production by installing ponds, wells, water spreaders, terraces, irrigation systems, and other improvements. Farmers in Puerto Rico need to be taught to seek technical assistance in grasslands improvement and in soil and water

conservation from their local agricultural agencies.

Control of weeds and brush is also an important factor in grasslands management. Pastures in Puerto Rico are continually invaded by weeds and brush. In well managed kudzu-grass pastures the kudzu controls most weeds by pulling them down and smothering them. Very little weeding is required in pastures of this type. One of the most economical and practical ways of weed and brush eradication in pastures is by the use of herbicides. There are various selective herbicides available on the market that can be used for this purpose.

Insects and diseases in pastures also need to be controlled as part of good grasslands management, but little attention has been given to these sources of damage in Puerto Rico. There are several insect pests and diseases that attack some of the native grasses and seriously affect production.

One of the more important insects is the chinch bug (*Blissus leucopterus* var. *insularis*) that affects the guineagrass pastures along the coastal plains. Heavy infestations of this insect in overstocked pastures on sandy lands will destroy in a period of 2 years a pasture which otherwise would have lasted over 12 years in good production. No attempt has been made to control this pest, although various methods for its control are known and practiced elsewhere. Other insects, such as army worms, mole crickets, white grubs, etc., cause considerable damage to pasture and other forage crops on the island.

Losses to pastures also result from diseases caused by fungi, such as the *Helminthosporium* that attacks Napier grass and the *Cercospora* that occurs in the foliage of various other grasses. A new species of ergot, not previously reported, was recently found by the Federal Experiment Station to attack the seeds of guineagrass. It was observed that a high percentage of seed produced in the southwestern region of Puerto Rico is non-viable. One of the contributing causes was found to be the high prevalence of ergot in this area. In the Aguadilla area, however, fields of guineagrass appear to be free of ergot. Thus, production of guineagrass seed should be in the region of Aguadilla or at the governmental seed farm at Isabela, where ergot does not prevail.

The gamelotillo, another important pasture grass of the moist uplands, was found infested with ergot caused by *Claviceps paspali*. When

ingested by animals, this disease may cause poisoning. In order to stop formation of the toxic fungus bodies, the pastures should be cut just after flowering of the grass or they should be grazed heavily at the beginning of the blooming stage.

Bermuda-grass is attacked by rust caused by *Puccinia cynodontis* and by a helminthosporium spot caused by *Helminthosporium cynodontis*. Steps should be taken to replace this native variety by the coastal Bermuda varieties that have been developed at Tifton, Ga. These new varieties are superior to the Bermuda-grass that is native to Puerto Rico and are well adapted to the dry coastal plains.

Sorghum, one of the important silage grasses for the southern coast, is attacked by a rust, *Puccinia purpurea*, which causes constant defoliation and even death in some species. Resistant varieties are known and should be introduced for testing.

Numerous other diseases attack the most important pasture and forage plants in Puerto Rico, but little is known about them. These diseases require further study to determine measures for their control.

Grasslands Research and Education

The utilization of grasslands for increased and more efficient production is relatively new to Puerto Rico, and few farmers have as yet realized the importance of this undeveloped resource. The interest of farmers in developing the grasslands potential must be aroused, but at the same time farmers must know what to do and how to do it. This requires research to obtain the basic information, and education to get the farmers to apply the knowledge that is developed.

Only a limited amount of research work relating to grasslands has been done in Puerto Rico. Until recently, investigations involved only a few forage grasses that were used as soilage. No research work was conducted on native grasslands and very little on cultivated pastures. Such important phases of pasture research as breeding of pasture plants, grazing systems, fertilizing, seeding, and cultivation of pastures were neglected.

The first pasture research work in Puerto Rico was started in 1937 by the Soil Conservation Service with a study of the botanical composition of pastures, and of the influence of soil, climate, and grazing animals on the various pasture types. A

collection was made, for the first time on the island, of all species of grasses that occur in the numerous types of pastures. These were planted in experimental plots to assess their forage and soil conservation value. The various pasture types were classified and mapped. Studies on plant succession were undertaken covering all the ecological regions of the island. These studies were continued until 1942 when the grass collection was moved to the Institute of Tropical Agriculture at Mayagüez, since then absorbed by the College of Agriculture and Mechanic Arts of the University of Puerto Rico. Exploratory surveys were made in various tropical countries of South America. About 100 new species of grasses were introduced, of which nearly 30 species have become adapted to the island.

In 1944 the Puerto Rican Experiment Station obtained planting material of all the grasses from the Institute of Tropical Agriculture, and regional tests of promising pasture species were started by this station. Since 1946, the College of Agriculture and Mechanic Arts has been working with the grass and legume collections. It was not until 1946 that the Experiment Station started a grass-breeding program.

Shortly afterward studies on chromosome numbers in grasses and studies on fertility were undertaken by the Federal Experiment Station at Mayagüez. Experiments were also started with legumes to determine nitrogen fixation and forage yield on different soil types, and tests were initiated on legume palatability and toxicity. The most recent study started at the Federal Station concerns the various diseases affecting the most important forage grasses.

The Bureau of Plant Industry and the Soil Conservation Service in cooperation with the Puerto Rican Experiment Station are carrying out studies relating to the establishment, management, and fertilization of various kudzu-grass mixtures in the mountain regions.

While the research already undertaken in Puerto Rico represents a start in building up the basic information needed for developing the economic potential of the island's grasslands, the work is not geared to the kind of broad development that should take place over the next few years. The need now is for a wide frontal approach to the grasslands problem. Research should be fitted in so that it is part of an overall program for grass-

lands development and meets the practical needs both of farmers and those who work with farmers. The overall grasslands program should be planned, developed, and carried forward as a joint responsibility of all of the agricultural agencies on the island.

The Puerto Rican and Federal research agencies that have been concerned with grasslands up to now should bring together the applicable information that is already available on pastures and forage crops in Puerto Rico and continue their research work from there, giving emphasis to the following phases: (1) Selection and testing of superior ecotypes of native grasses and legumes for the various ecological zones of the island; (2) testing of promising introduced grasses and legumes; (3) breeding work on grasses and legumes; (4) determination of desirable mixtures of grasses and legumes in the various ecological regions of the island; (5) studies on pasture and forage crop fertilization and liming; (6) comparative studies of the various systems of grazing under different field conditions and with different types of pastures; and (7) studies on pasture management, control of insects and diseases, brush and weed eradication, and other related problems.

More research workers trained in pasture and forage crops are very much needed on the staffs of the agricultural research agencies in Puerto Rico. Usually the pasture and forage crop research has been left to veterinary or livestock specialists or to agronomists without the proper training for this special type of work. As a result there has been a lack of interest in, or knowledge of, procedure to develop research on native pastures. The basic responsibility for pasture and forage research in Puerto Rico should rest with the local Experiment Station and that agency should be in position to exert its leadership through specialists who are well trained in this kind of work.

Results obtained through research should be tested cooperatively by representative farmers working with agricultural extension agents as well as with representatives of other Puerto Rican and Federal agricultural agencies, such as the Soil Conservation Service, Farmers Home Administration, Land Authority, Production and Marketing Administration, and others. Steps should be taken to establish close working relationships among workers in the fields of research, education, extension, and other services so that farmers may

receive more effective help in grasslands improvement.

A vigorous educational program is needed to focus the attention of farmers on the economic potential of their grasslands and to help them apply measures that will increase pasture and forage production and effectively utilize the total output for livestock feeding. The Extension Service should have the primary responsibility for leadership in the educational work, but it needs the cooperation of all other agencies in teaching farmers how to make the best use of their grassland resources.

The extension personnel assigned to work on grassland problems has been wholly inadequate for Puerto Rico. So far there is only one specialist who spends any time on pastures and he works in three different fields—bees, hogs, and pastures. Naturally, one-third of a specialist's time on pastures is not sufficient for adequate attention to all of the educational and advisory work that needs to be done in this important field. Certainly, if pasture improvement and effective grasslands utilization are to be achieved in any reasonable time, it is obvious that the Extension Service needs trained personnel to devote full time working with farmers on grasslands problems. This cannot be left to workers in other fields.

The agronomic aspects of forage production and pasture management should be handled by specialists who are trained in soil fertility, soil conservation, cropping practices, and forage-crop production. They should understand the relationship between good forage and pastures and animal

nutrition. Their work should be in close association with other agricultural workers, especially those in the extension and research fields concerned with problems relating to the utilization of grasslands. Representatives of credit agencies also need to be reached, so that they will understand the advantages of making loans to farmers for improving the use of their grasslands by establishing improved pastures and increasing livestock production.

In order to show farmers what can be accomplished through grasslands improvement and good pasture management, a number of demonstrations should be established on farms in the different parts of the island. Farms cooperating in carrying on a demonstration project should be typical of the local area with respect to size, general topography, soil, and other conditions characteristic of the locality. These demonstrations will provide concrete examples that will serve as a guide to other farmers in the community. In addition, farm youth enrolled in 4-H Club work and in vocational agricultural courses should be encouraged to participate in grasslands improvement and pasture management projects. The possibilities of grassland improvement and pasture management on farms owned by the Puerto Rican Government should not be overlooked for demonstration purposes. Agricultural agents and technical advisors concerned with pasture and forage problems need to gain the confidence and cooperation of farmers in more effective grasslands utilization. Demonstrations, group discussions, and field days for farmers are important in this respect.

Chapter VIII

Developing New Land by Reclamation

Puerto Rico has had to focus more and more attention on reclamation as a possible means of expanding the total land area available for agricultural production. Beginning in the latter part of the last century, when the population pressure against limited natural resources already was great, the Spaniards started reclaiming land along the south coast by irrigation. During the first decade after Puerto Rico came under United States sovereignty, initial steps were taken by the local Government to establish a public irrigation system on the basis of the earlier start that had been made in that coastal area by private landowners. This system now includes more than 50,000 acres of highly productive soils which are being profitably irrigated on the south coast and about 9,000 acres in the northwestern part of the island. Additional acres have been brought into productive use by reclaiming some salty and wet lands which otherwise would have remained idle.

But the need for still more land grows and grows as the population continues to expand sharply and further intensifies the already acute problem of too many people on too little land. And so now, greater attention is being focused on reclamation as a means of bringing more land into condition for productive use. Under present circumstances, however, reclaiming land for agricultural use is expensive, and, the costs have to be carefully weighed against the possible benefits, both public and private, that may be derived from any such undertaking.

Because reclamation is costly, the Puerto Rican Government cannot afford to spend any of its limited funds on a project without first being certain that doing so will return to the economy more than the cost involved. This practical con-

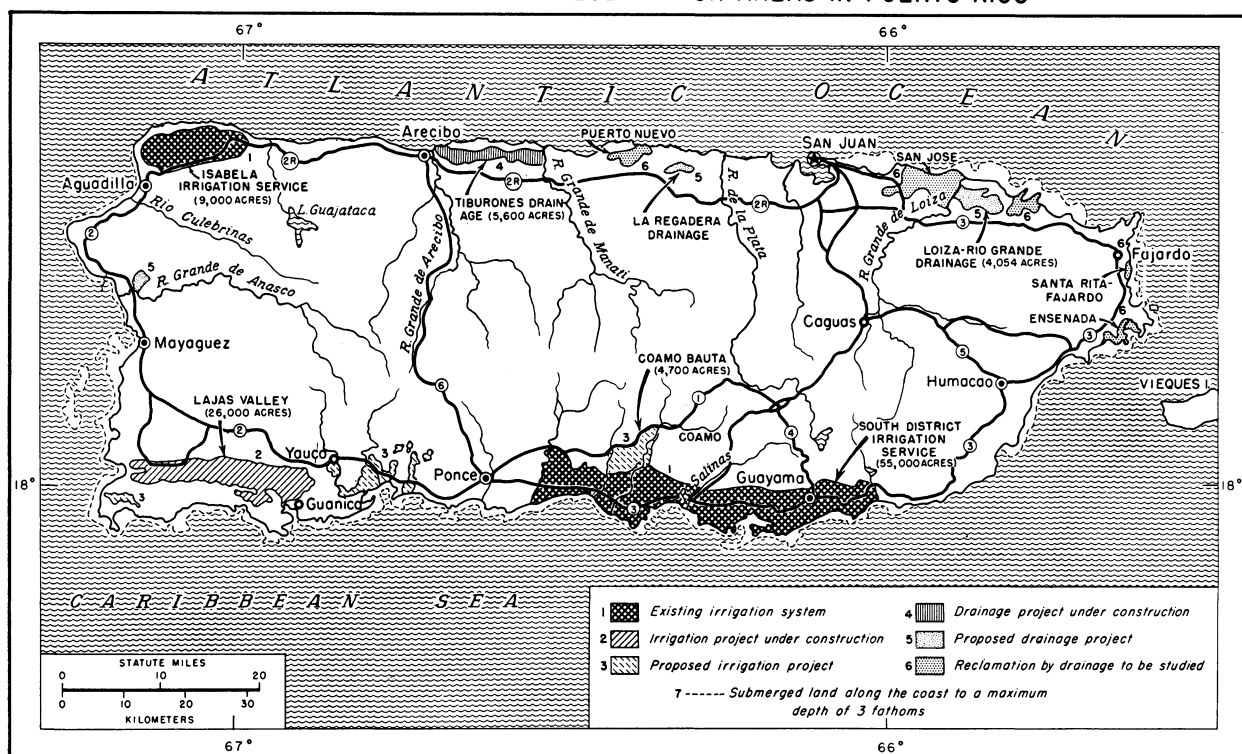
sideration must be recognized from the outset of planning. It is a factor that greatly restricts the amount of land that can or should be reclaimed in Puerto Rico.

Even where reclamation may be economically feasible on the island, the question well may be raised as to whether it should be undertaken so long as such a large proportion of the agricultural land already available is not being fully utilized because of improper cropping, neglect, or other reason. More effective use and improved management of the existing land, greater diversification of agricultural production, and the application of good farming practices, including use of larger amounts of fertilizer and better seed, will do far more to meet the basic needs of the economy of Puerto Rico than will any development of new land areas.

Nevertheless, in certain parts of the island there are lands that could be improved by reclamation and made more productive and of greater benefit to the whole economy. It is important to make sure that such development will result in a net increase in agricultural production for the island. Otherwise there will be a shift in production from land now in use to the newly developed lands, thus leaving the older land virtually idle or producing below its capacity. There is no net gain for the economy in such a situation even though reclamation has made additional land available for cropping.

Altogether, there are about 159,900 acres in Puerto Rico that may be reclaimed (table 33). Some of this land is already in the process of reclamation. The biggest part, however, remains for future study and includes about 40,000 acres of submerged lands around the seacoast. If all

EXISTING AND PROPOSED RECLAMATION AREAS IN PUERTO RICO



A considerable amount of land in Puerto Rico has already been reclaimed by irrigation and drainage and work is underway to improve additional areas and make them more productive.

of the area except the submerged lands were reclaimed, the total cropland actually available for agriculture on the island would be increased nearly 10 percent.

Work is under way by the Puerto Rico Water Resources Authority and the Land Authority to

reclaim a total of about 35,780 acres. This includes 5,600 acres to be drained in the Tiburones area, 4,180 acres to be drained in the Loíza-Río Grande area, and 26,000 acres to be irrigated and drained in the Lajas Valley. The reclamation of about 4,800 acres of dry land in the Coamo area and about 1,200 acres in the La Regadera swampy area has been studied. Also, a study has been made of the method of reclaiming about 10,481 acres of salty land in the Lajas Valley which would be in addition to the land to be irrigated and drained there.

Table 33.—Possible reclamation areas in Puerto Rico

Area	Method of reclamation	Acres
South coastal plain:		
Lajas	Irrigation and drainage	26,000
Do	Salt leaching with irrigation and gypsum.	10,481
Coamo	Irrigation	4,800
Other	Salt leaching with irrigation and gypsum.	26,619
Poorly drained soils elsewhere throughout the island. ¹	Pumping and/or irrigation.	52,028
Submerged coastal areas.	Pumping and drainage	40,000
Total		159,928

¹ An additional 6,784 acres is included in the 26,619 acres listed as "other" under the south coastal plain item.

Tiburones Drainage Project

The Tiburones drainage project is in one of the largest swamp areas of the island. It is located in the municipalities of Arecibo and Barceloneta along the north coast. The elevation of this area is low, being mostly from 16 to 40 inches above mean sea level. The high tide, and the slowness of drainage due to the extremely low grades and long flow distances, make satisfactory drainage by gravity impossible. This drainage problem is

made more difficult by the frequent blocking of the mouth of the Arecibo River because of sand bars piled up by wave action and by occasional flooding of the lower river. Occasional overflows from the Manatí River and the runoff from the surrounding watershed also contribute to the flooding of the area.

The conditions existing in the Caño Tiburones area indicate that the drainage project already undertaken should satisfy four fundamental requirements, namely: (1) Diversion, as far as possible, of the runoff from the higher lands; (2) protection of the lowlands from the overflows of the Arecibo and Manatí Rivers; (3) drainage by gravity of the higher areas of the lowlands that may be so drained; and (4) pumping of the drainage from the rest of the lowlands. It has been assumed that the water table should be kept normally 3 feet below the surface.

Studies for the drainage of the Tiburones area were started in July 1945. Actual work on the project, such as excavation of canals, construction of dikes, bridges, pumping stations, etc., began in February 1949. A total of \$1,500,000 was appropriated for the project and up to the end of June 1951 expenditures totaled \$864,810.

Of the 5,600 acres in the Tiburones drainage project, 5,423 acres belong to the Land Authority of Puerto Rico and the remainder is in the hands of private owners. In addition to its present holdings, the Land Authority is acquiring, either by agreements or expropriation, a total of about 1,300 acres of land in the same region. This additional area of land is distributed among 61 privately owned farms bordering the swampy area. The canals under construction are being excavated through these farms.

About 90 percent of the total area to be drained is swampland on which ferns, sedges, and cattails make up the dominant vegetation. About 400 acres of the land and about 75 percent of the additional area to be acquired by the Land Authority are planted to sugarcane and some minor crops.

In general, the soils in this area are fertile. After the drainage system is installed, the land will be highly adapted to growing sugarcane. Of the 5,600 acres, about 4,200 acres could be under cultivation at any one time; the rest would be in fallow or occupied by canals, ditches, and roads. It is estimated that the reclaimed land would average

around 35 tons of sugarcane per acre, or a total of about 147,000 tons from the 4,200 acres.

Even though the drainage project has not yet been completed, advantages are already being derived from the work done so far. Drainage has been provided for about 200 acres of land in Monte Grande, Santa Barbara, and Tiburones farms on which the planting of sugarcane had been abandoned because of the high water table. The combined operation of the pumping station and the southwest canal lowered the water table in all the adjacent lands and increased the acreage suitable for sugarcane.

When the drainage project is completed, it will also benefit a few hundred acres of adjoining lowlands which are now cultivated with more or less difficulty and reduced efficiency because of their low elevation and poor drainage. The drainage of these lands will be improved considerably after the water table of Caño Tiburones is lowered.

Drainage of the Tiburones area will unquestionably increase land values. The value of the land without drainage is less than \$15 per acre. The reclaimed lands are expected to have a market value of \$350 per acre. This increased value would be derived through an investment of about \$270 per acre to provide the drainage. In addition, the drainage of these lowlands will reduce or eliminate sources of malaria infection and help to improve public health.

Loíza-Río Grande Drainage Project

The Loíza-Río Grande drainage project includes the poorly drained soils located in the municipalities of Canóvanas and Río Grande at the east of the Loíza River. Adequate drainage for this area of about 4,180 acres should satisfy the following requirements: (1) Protection of lowlands from overflow of the Loíza, Herrera, and Espíritu Santo Rivers, and the Lajas Brook; (2) diversion, as far as possible, of the runoff from the higher lands to prevent flooding of the lowlands; and (3) pumping of the drainage of the lowlands from which drainage by gravity is not possible. The lowlands are to be protected from the overflows of the rivers through repair of existing dikes and construction of new ones.

Studies for the drainage of the area started in July 1948, and construction of the drainage works began in October 1950. Up to the end of June 1951 a little over \$50,000 had been spent out of an

estimated cost of \$865,000 for the project. The investment per acre drained is expected to be around \$235.

Approximately half of the land in the drainage area is owned by the Land Authority, and the remainder is privately owned. The Land Authority purchased this land from the Fajardo Sugar Growers Association in 1947, and is contemplating acquisition of the lowlands within the drainage area which are privately owned.

About 971 acres in the drainage area are planted to sugarcane, and about 486 acres of the lowlands are planted to sugarcane and are drained by a pumping plant, with a capacity of 30,000 gallons per minute, installed by the Fajardo Sugar Growers Association in 1928.

The actual area to be drained totals 3,573 acres. Of this amount, about 2,680 acres could be under sugarcane cultivation at one time, leaving the rest for fallow and for drainage canals and ditches. The soils are fertile and it is estimated that sugarcane yields on the reclaimed lands would average around 35 tons per acre, producing 94,000 additional tons of cane. The drainage of these lands would also reduce sources of malaria infection and thus be of benefit to public health.

Lajas Valley Development Project

The most extensive multiple-purpose reclamation project undertaken in some time in Puerto Rico is designed to develop a vast area of land in the Lajas Valley and thus open up what virtually amounts to a new and important frontier for the island. Designated as the Southwestern Puerto Rico Project by the Water Resources Authority, it involves a complete development of water resources for irrigation, power, and water supply, and includes necessary drainage.

The Lajas Valley proper, located in the southwestern corner of the island, covers about 36,481 acres of land and has a mean annual rainfall of about 31 inches. About 26,000 acres of this land will be under irrigation. The developmental project presents a means of rehabilitating, adding to, and preserving agricultural lands of great value. The Lajas Valley is a naturally dry area and production is greatly limited by the lack of water. The irrigation and other features of the project will have a tremendous impact on that comparatively sparsely populated area by providing the means for increasing production. If development

is properly guided, it will open new employment opportunities for additional thousands of workers, create new living space, encourage new industry and commerce, raise the general standard of living throughout the area, and result in a more favorable balance in the general economy of the island.

The Lajas Valley area covered by the reclamation project has 479 farmers who have all or part of their farms in the actual area to be irrigated. These farmers control around 56,100 acres of land, and this includes land which slopes out of the valley. Most of the land is owned in large blocks by a few farmers. Six percent of the farmers with farms of 200 or more acres control around 80 percent of the land. The area in farms includes the Land Authority's farm of 10,195 acres and the Puerto Rican Agricultural Experiment Station substation farm of 485 acres. Within the area covered by the reclamation project, these farmers along with the Puerto Rican Government own 27,172 acres. These farmers also control approximately 36,900 acres of the land which slopes out of the Lajas Valley. Those with farms over 200 acres control 85 percent of this land.

The present pattern of agricultural production in the Lajas Valley is based primarily on pasture and livestock, with sugarcane being the main crop on land already under irrigation. A study made during the calendar year 1950 showed that of the total of around 56,100 acres in and near the reclamation area, approximately 18,900 acres were cultivated and the remainder was in pasture. The acreage under cultivation includes around 7,700 acres already under irrigation. This land is planted to sugarcane. Most of the land now irrigated belongs to the Land Authority. The most important crop is sugarcane, of which 10,313 acres were harvested and 281,000 tons produced in 1950 with a value of around \$2,500,000. Approximately 12,200 of the 18,900 acres of land under cultivation are in the total of 26,000 acres to be included as irrigated lands under the reclamation project. The remaining land to be irrigated is mostly in pasture.

The second most important crop of the Lajas Valley area is corn, 1,500 acres being harvested in 1950. The land to be irrigated produced around 12,500 hundredweight of corn with a value of \$70,900. Other less important crops were also harvested. Of the total value of all crops grown

in 1950 on the lands to be irrigated it is estimated that 96 percent was derived from sugarcane. The cattle industry is of some significance to the Lajas Valley area and some poultry is raised.

On the basis of the 1950 study, the total gross income for the 26,000 acres in the Lajas Valley to be irrigated is estimated at around \$3,000,000. Of this amount, 82 percent came from crops, principally sugarcane, and the rest from livestock products, especially milk.

The lands of the Lajas Valley are mostly deep, fertile, alluvial soils that are benefited by irrigation, although some need drainage also. With adequate supplies of water from irrigation, and the necessary drainage, the area has the possibility of becoming perhaps the best agricultural section on the island.

While the Lajas Valley proper covers 36,481 acres, no detailed study has been made to determine the exact acres to be deducted from this total for other than cultivation. In general, such deductions range from 10 to 20 percent, but in this project deductions amounting to 33 $\frac{1}{3}$ percent have been made. This large average deduction has been made arbitrarily because of two important considerations—assured acreage and assured water supply.

The fresh water supply being brought to the Lajas Valley for irrigation under the Southwestern Puerto Rico Project will be sufficient in the average water year to irrigate 24,000 acres at a rate of 5 acre-feet per acre. Pumping the return seepage is estimated to be sufficient to irrigate an additional 2,000 acres. Therefore, in order conservatively to balance the water supply with the lands to be irrigated, it was found that the acreage may be limited by the water supply that is available. On this basis, the total acreage to be irrigated is placed at 26,000 acres.

In the future, if it is found that additional water can be made available through a larger amount of return seepage than estimated, or by some possible extensions of the water source areas, and there are more good lands than now estimated as forming the net area for cultivation, then the irrigation district may be considerably increased. For example, there are 10,481 acres of salty land in the Lajas Valley. About half of this acreage may be reclaimed by washing the salts with 5 acre-feet of good fresh water if adequate drainage is

provided; the other half may be reclaimed with gypsum at the rate of 2 tons per acre.

The plan for the irrigation system provides for a main canal heading at the regulating reservoir on Río Loco, about 1 mile upstream from the Yauco-Sabana Grande road crossing, and following the right bank downstream some 5,000 feet to the northeast entrance of the Lajas Valley, thence, westward for a distance of about 25 miles along the north fringe of the valley, near the base of the hills, to Boquerón. The distribution system will consist of various sized laterals branching out to serve water to lands south of the main canal. A lateral will cross the valley with a low fill on the saddle and will irrigate lands on the south side of the valley. Irrigation canals and laterals on the south coastal slopes will be supplied by pumping the irrigation return water from the main drainage ditch.

The drainage plan essentially provides for two large capacity drainage canals following the low portion of the valley profile. One canal will extend from a point near the divide eastward for a distance of about 14 miles, draining the Anegado and Guánica Lakes, and emptying into Guánica Bay. Another canal will extend from a point near the divide westward for a distance of about 5.7 miles, draining the Cartagena Lagoon and emptying into the Laguna Rincón, which opens into the ocean. Secondary drainage will be supplied by small drains located normal to and discharging into the main drainage canals. Draining the Cartagena Lagoon would be detrimental to the many kinds of birds and waterfowl found there. For this reason, it should not be drained but rather developed as a wildlife refuge.

The over-all capital investment in the Southwestern Puerto Rico Project is estimated, as of July 1, 1950, at \$26,789,000. For purposes of constructing and financing, this multiple-purpose project is divided into two main parts. The first part consists of the power and water source feature, including all facilities from the headwater reservoirs through power plant No. 2. The second part includes the Río Loco Dam and Reservoir and the irrigation distribution system and this is to be financed by the Puerto Rican Government at an estimated cost of \$6,307,000. The cost of constructing the first part, the power and water source feature, is estimated at \$20,482,000. Of this amount, \$11,704,000 is allocated to the power as-

pects of the project and is to be financed by the Water Resources Authority. The remaining \$8,778,000 is allocated to that portion of the water source phase which provides water for irrigation purposes, and this amount is determined to be the Government's share of the cost of the first part of the project.

Therefore, the cost of the irrigation feature of the Southwestern Puerto Rico Project is estimated at \$8,778,000 for the development of the water source for irrigation, plus \$6,307,000 for the development of the irrigation system, or a total of \$15,085,000. Since 26,000 acres of land are to be irrigated, the cost of the irrigation part of the project is equivalent to around \$580 per acre.

The total cost to reclaim an additional 5,000 acres of salty land with fresh water and drainage is estimated at \$340,000, or \$68 per acre. Another 5,000 acres of salty land requiring also gypsum could be reclaimed at an estimated cost of \$720,000, or \$144 per acre. Work in reclaiming these salty lands, however, should be deferred until after the 26,000 acres are brought under irrigation in order to make sure that the developed water supply is ample for all needs.

On the basis of the plans and the progress being made, it will be at least 4 years before the entire 26,000 acres will have irrigation available. The construction of the Yauco Dam was completed early in 1952. This dam has a storage capacity of 15,000 acre-feet, and will provide water to irrigate about 6,000 acres. The tunnel from the Yauco Dam to Río Loco was also finished early in 1952.

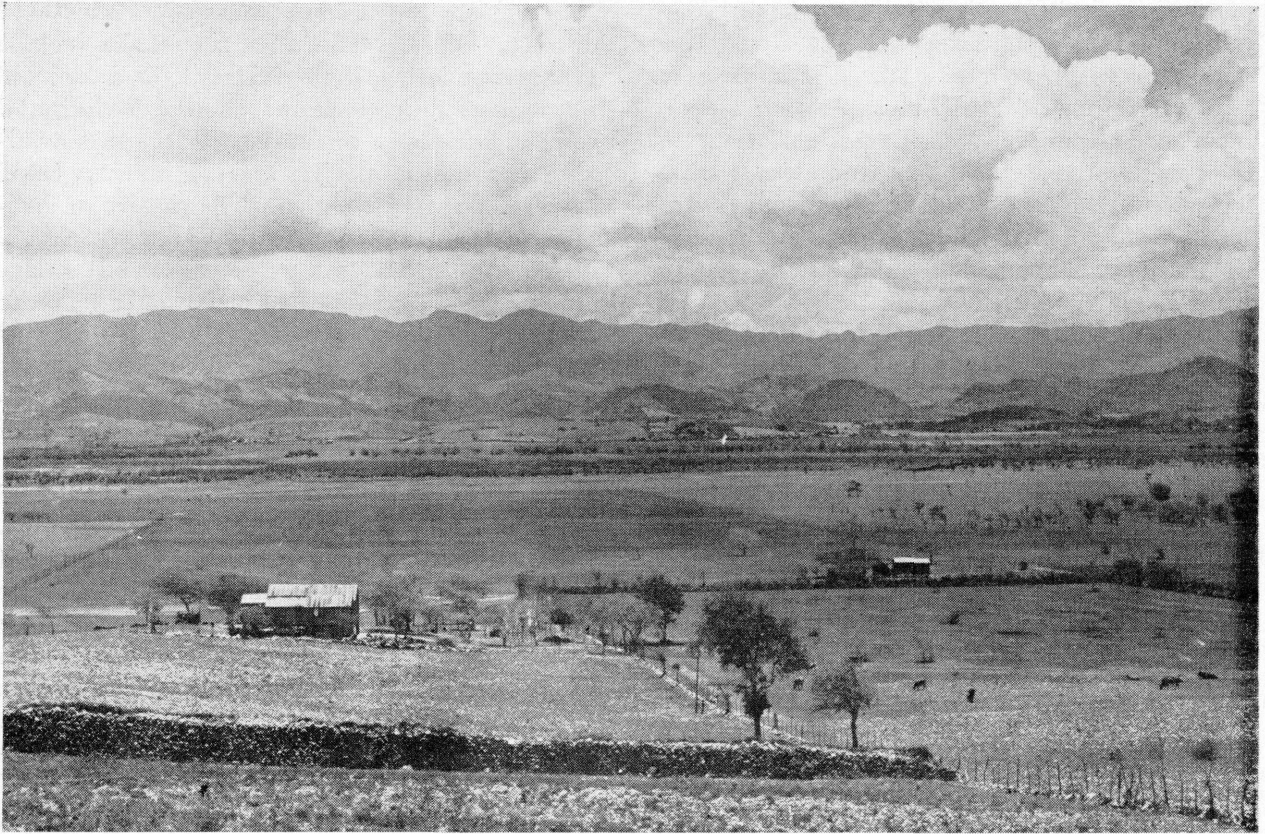
The studies for the location of the irrigation channels, including the design of the structures, have been completed. With the necessary funds from the Puerto Rican Government made available on time, it is estimated that the irrigation system can be completed by the end of 1954 or shortly thereafter. In 1955 when the water from the northern side of the mountain range is collected and diverted, there is expected to be enough water to irrigate 25,000 acres.

The pattern of agricultural production that is to develop in the Lajas Valley after the necessary irrigation and drainage systems are installed is a matter of public interest in view of the large expenditure of public funds that is involved in this project. The public has a right to expect that the higher level of agricultural production and other

economic activity that takes place in the Lajas Valley as the result of irrigation will represent a net increase to the total economy of the island. It is for this reason that the Puerto Rican Government should give immediate attention to the kind of agriculture that is to develop in the Lajas Valley. From past experience in the agriculture of Puerto Rico, the economy of the island cannot afford a policy of drift in connection with this important project.

As the situation now stands, it is quite certain that if nothing is done to guide the course of agricultural development on the land to be irrigated in the Lajas Valley, practically all of this land will be planted to sugarcane. That would be most expedient from the standpoint of the individual grower, and almost automatic. But if this happens, and with the marketing quotas under the Sugar Act still in effect, it will merely mean a shift in sugarcane growing from one area to another. It is likely that the land on which the sugarcane had been growing would not be utilized as effectively, and it even might be left virtually idle. Under such a circumstance, little will have been gained for the economy by the expenditure of public funds to irrigate the Lajas Valley.

Moreover, Lajas Valley land is not really needed for sugarcane production as long as the good lands in other areas now producing sugarcane on the island are capable of growing far more than the 1952 record tonnage, irrespective of the effect of the sugar marketing quota. The 1952 acreage, for example, could be pared down by at least 25 percent and still, by improved cultural practices (including use of considerably more nitrogen and improved varieties of cane) on about 300,000 acres of the good lands now growing sugarcane, the island could grow as much and even more than the total already being produced. And this great volume of sugarcane from a smaller acreage would be grown more economically, on the average, than is now the case. So the problem in Puerto Rico is not one that requires more land for sugarcane. Rather, it is a problem that calls for greater production on fewer acres and the release of extra land from sugarcane growing for additional productive uses so as to encourage greater diversification of agriculture and improved land use without any impairment but with benefit to the sugar industry as well as to the rest of the economy.



This general view shows a portion of the Lajas Valley, a naturally dry and fertile area, which is being improved by irrigation and drainage under a governmental reclamation project. When work is completed 26,000 acres will have irrigation available. What the future pattern of agriculture will be in the Lajas Valley hinges largely on what the Puerto Rican Government may do to help guide its development.

With the development of irrigation, the Lajas Valley becomes ideal for diversified farming and in such a production pattern some sugarcane could be included to provide one of the cash crops. The types of soil found there are suited to a wide range of crops, and the fertility of the land assures high productivity under irrigation. Furthermore, the very limited rainfall in the area creates an almost perfect situation for the control of diseases and insects. Sprays or dusts may be applied to a crop without too much fear of the materials being washed away by the next rain before they have had a chance to do their effective work. Altogether, the conditions are such that crop growth virtually can be regulated by the will of the farmer. There are but few areas in the world where the combination of factors so favorable for crop production exist as in the Lajas Valley.

But the development of a pattern of agricultural production for an area cannot proceed on theory alone. Basic information in regard to the

specific crops, best varieties, agronomic and cultural requirements, and attainable yields in the Lajas Valley must first be available since farmers will not and should not undertake risky experiments which they cannot afford. As much as possible of the information required should be in hand and ready for farmers as soon as the Lajas Valley project nears completion but before the producers start thinking about their cropping plans.

The store of knowledge needed as a basis for agricultural diversification in the Lajas Valley under the entirely new conditions that will prevail there with irrigation and drainage, must be developed by the Puerto Rican Government. The basic responsibility for such work should rest with the Puerto Rican Experiment Station, and that agency will need all the cooperation and help it can get from many other sources, both local and Federal, in order to accomplish what is required within the time limit that must be faced. The Experi-

ment Station will require funds and facilities for this important assignment, and the actual tests with crops will have to be made right in the area.

Fortunately, the Experiment Station already has a good farm which is the Lajas Substation, and the Land Authority has some land already being irrigated in the Lajas Valley. As much as necessary of all of these agricultural landholdings should be made available for the practical studies that must be conducted.

In essence, this amounts to establishing a pilot farm in the Lajas Valley area that will be concerned with the adaptation and economic production of commercial crops under irrigation and mechanization. Since a considerable amount of land in the area, mostly the surrounding foothills and slopes, will not be under irrigation, attention should also be given to dryland farming problems of the region so that the uses made of irrigated and nonirrigated lands will result in an agricultural balance that will be most productive.

In considering the kinds of crops that may be produced under irrigation in the Lajas Valley, the possibility of establishing a commercial vegetable industry similar to that which exists in the southern part of Florida should be thoroughly explored. This could provide products for continuous fresh market sale on the island and for shipment to the States during certain late fall and winter months, as well as provide vegetables for local canning and other processing for consumption on the island.

With a good volume of production concentrated in such an area and adequate organization among the growers, it would be possible to have central facilities for properly preparing the vegetables for fresh market shipment and for processing. This important feature and the unusual control that would be possible over growing conditions would give rise to some outstanding advantages not now found in any other section of the island. And certainly, with the kind and quality of vegetables that could be marketed from the Lajas Valley, the per-acre returns would exceed those from sugarcane besides providing more continuous employment for a greater number of workers.

Additional crops that should be explored include long-staple cotton of varieties superior to those now grown on the island. Cotton is now produced in Puerto Rico on nonirrigated lands and the yields are low. The right kind of cotton

grown under irrigation in the Lajas Valley should do very well. Diversification should also include grain crops such as high-yielding hybrid corn and sorghums for livestock and poultry feeding and commercial sale on the island. With grain available, a substantial poultry and egg industry could be developed in the region. The pattern of agricultural production in the Lajas Valley area should include improved pasture, silage, and soilage crops, even in crop rotations on irrigated lands, to support a healthy dairy industry. More swine could also be produced by utilizing local sources of feed. Many other crops should be given consideration, including commercial production of paddy rice, pineapple, bananas, citrus, and other fruits so as to make the fullest use of the total land resources of the area with and without irrigation.

Related to the problems raised by the pattern of agriculture that should be encouraged in the Lajas Valley is the question of the kind of farm tenancy that should prevail in that area. At present, most of the land is in the hands of a few large owners. From the standpoint of the economy as a whole, and in view of the large investment of public funds to develop the area by irrigation, drainage, and other means, some change in the farm ownership pattern now existing in the Lajas Valley would be desirable. If a diversified agricultural industry is to be established in that area, then family-type farms should prevail. There is ample experience on the island and elsewhere to show that family-type farms are best for this purpose. The family-type farms established by the Farmers Home Administration provide a good illustration of the extent to which production can be increased compared with what these same lands produced when managed as part of a large plantations.

The Puerto Rican Government should acquire by purchase the land in the Lajas Valley and divide this land into family-type farms in a systematic layout. The number of acres that should be contained in each farm would depend on whether all or part of the land included is irrigated. In any event, great care must be taken to make sure that the acreage provided in a family-type farm represents a sound economic unit. Under the conditions that probably would prevail, it would seem that family-type farms should have perhaps 30 acres of irrigated land or possibly more depending upon what the particular farm is to produce. In family-type farms that would be

partially served by irrigation, the size probably should be determined by establishing a ratio of three acres of nonirrigated land to one acre of irrigated. Thus if one farm layout has only 25 acres of irrigated land and it should have the equivalent of 30 irrigated acres, there should be added to it 15 acres of adjoining nonirrigated land in order to make up for the 5-acre deficiency in irrigated land.

In order for the Puerto Rican Government to buy the Lajas Valley land for subsequent division into family-type farms, some basis of land appraisal would have to be followed. A reasonable approach would be to base the appraisals on the average value of \$150 per *cuerda* (0.9712 acre) which was paid by the Land Authority for land in the Lajas Valley purchased from Russel & Co. This is considered as representing a fair market value for the land that was acquired. The total bought amounted to 10,400 *cuerdas* which included 5,572 *cuerdas* of poor agricultural land and the Guánica Lagoon, the value of the land suitable for irrigation being estimated at \$276.75 per *cuerda*. If the cost of developing the irrigation project is added to the estimated average market value of the land in the Lajas Valley, the average value of land in the whole area increases so that a 30-acre family-type farm might require an investment ranging from around \$20,000 to \$25,000 for the land alone, depending upon whether the entire farm was under irrigation and other factors.

Another procedure that the Puerto Rican Government might follow in purchasing land in the Lajas Valley is to have an official board of appraisers determine all land values in the area at price levels corresponding to present conditions but without reflecting any increase in values due to the proposed irrigation and drainage improvements, and without adding any speculative values based on anticipation of future improvements. Coupled with this there would have to be legislative action to impose a lien on each tract of land benefited by the improvements; the amount of the lien to be in direct proportion to the difference in value of the land before and after the drainage and irrigation facilities are provided, this enhancement value to be determined by the official board of appraisers. There would be no interest charges and no requirement for retiring the lien at any specified time, but it could be retired by

the owner if desired by making payments from surplus farm income. It would have no relation to payments for irrigation water. This lien, which would represent the enhanced values of the land, would remain (unless or until retired) the property of the Puerto Rican Government. It would be a real value and asset to the island whether in the nature of a joint ownership of the land, or of revenue resulting from the retirement of the lien.

If the Lajas Valley land is acquired by the Government, the responsibility for dividing this land into family-type farm units should rest with the Puerto Rican Department of Agriculture since that agency also administers the land law, especially title VI which concerns farm settlement. However, this Department should enter into a working agreement with the Farmers Home Administration so that the resources, experience and the valuable assistance of the Federal agency may be enlisted in establishing family-type farms that will prove successful. In dividing the land, provision should be made to preserve the family-farm pattern by safeguarding against the subdivision or consolidation of holdings at some future time. This may be done through a stipulation in each deed which would prohibit subdivision of a family-type farm, and would permit all or any part of an individual farm in the area to be consolidated only if this is first approved by the appropriate agency of the Puerto Rican Government from which title to the land was originally obtained by the initial purchaser.

The Puerto Rican Government could finance its purchase of all the land necessary in the Lajas Valley area for subsequent division into family-type farms. However, it is not in position to keep these funds tied up in the mortgages that would be required to finance family-type farm ownership. The farm purchase loans would have to be made by some lending agencies, such as private banks and governmental credit organizations. The Farmers Home Administration could, in all probability, do the necessary financing of family-type farm purchases in the Lajas Valley after the irrigation project is completed. However, in view of the large amount of money required, arrangements would have to be made to interest private lenders such as banks and insurance companies in making the loans which would be fully insured and in every way serviced by the Farmers Home

Administration. This should be an attractive investment for these private lending agencies since the loans would not only be insured, and therefore safe, but they would also help advance the economy of the island to the benefit of all business. Of course, in addition to a loan for purchasing a family-type farm, the owner probably would also need credit for equipping the place and also to finance production. Various loan agencies, including private banks, the Farmers Home Administration, and the Production Credit Association in Puerto Rico, extend this form of credit.

The success of the family-type farms in the Lajas Valley area will depend not only on the availability of credit, but also on the amount of self-help that these farmers are able to develop both through individual and combined effort. Cooperatives can be of great assistance in such a situation and they should be encouraged. Central facilities for packing, processing, and marketing products that would be produced on the farms of the area could very well be provided by cooperative action.

Another valuable organization would be a farm machinery and service cooperative that would make it unnecessary for the individual farmers to invest large amounts of money in heavy agricultural machinery and expensive equipment. The cooperative, for example, would have the heavy tractors needed for plowing and would be able to meet the high cost of spraying or dusting machines, and could provide both the equipment and the operators on a fee basis to cover actual cost. In this way, the high overhead of owning costly farm machinery and equipment could be held down, and the operating expense would be lower since the machinery and equipment would be given many more hours of use than if owned on a single family-type farm. The individual farmer would, of course, have to purchase for himself all of the other lighter machinery and equipment needed on his farm, including probably a small or medium size tractor for cultivating crops and doing other work around the place.

La Regadera and Coamo Projects

About 6,000 acres are involved in two land development projects which as yet have not gone beyond the study stage. These are the La Regadera drainage project and the Coamo irrigation project.

The La Regadera drainage project covers the swampy area called "La Regadera" which is located in the municipalities of Vega Baja, Vega Alta, and Dorado. It consists of about 1,200 acres, of which 1,150 acres belong to the *Pueblo del Niño* (Boy's Town) institution. Since the swampy area lies at an elevation of about two meters above sea level, the system that is proposed would provide drainage by gravity. The whole area for which drainage is contemplated is swampland on which cattails and sedges are the most noticeable kinds of vegetation. The soils are rather fertile.

The LaRegadera project would involve an estimated cost of \$156,000, or \$130 per acre for the drainage. The studies and investigations for this project were started in February 1951 and by the end of June 1951 they were 80 percent completed at a cost of slightly over \$3,600.

When the excavation of the necessary canals and building of the miscellaneous structures are finished, the reclaimed land will be ready for use. The soils are suitable for sugarcane and there are also some soils adapted for the production of pineapples and citrus. The Land Authority intends to subdivide the reclaimed area into proportional benefit farms for the growing of sugarcane. The acreage to be planted in cane in the reclaimed area will permit the Land Authority to reduce sugarcane production on other lands which could then be planted to pineapples. The La Regadera drainage project should be completed as soon as possible in order to enable the Land Authority to carry out its plans for the use of the land that will become available.

The Coamo irrigation project, which would be just above lands now irrigated on the south coast, proposes to irrigate an area located in the municipalities of Coamo, Juana Díaz, and Santa Isabel. It also includes some development of power out of the source that would supply water for irrigation. While the whole area consists of 15,900 acres, only about one-third can be readily irrigated.

The mean annual precipitation in this area is very low, only about 37 inches. The drier period extends from December to April, inclusive. The underground water supply is very deficient, and most efforts to obtain water from wells have failed. The average flow of water that would be available for irrigation from distant sources of supply is estimated at 27,350 acre-feet per year, or 37.7 cubic feet per second. Assuming the duty of water at

5 acre-feet (net) per year, after deducting 12 percent for conveyance losses, the flow is estimated to be sufficient for the irrigation of 4,800 acres of land.

There are 4,431 acres of fertile land with a mean slope of 8 percent suitable for irrigation. This area may be extended to 7,025 acres if some adjoining land suitable for pumping could be included in the proposed irrigation district. Further studies may add nearly 1,000 acres more if they are found suitable for irrigation. But engineering surveys already made indicate that there actually is sufficient water to supply only the 4,437 acres of land fit for irrigation within the irrigation district proposed by the Water Resources Authority. This does not include about 400 acres which could be irrigated by pumping.

The remaining lands, which total 11,063 acres, could not be irrigated either because of lack of water or because they are unsuitable for reasons of topography, soils, or other limiting factors. Most of these lands are not suitable for dry-land farming because they lack effective depth to store water from one season to another.

Most of the land in the area of the proposed Coamo irrigation project is held in large blocks. Of the 491 farms, 374 are about 3 acres or less in size. These small farms make up 74 percent of the total number of farms but they occupy only 2 percent of the land in the region. About 13 percent of the area is occupied by 84 farms ranging in size from 3 to 70 acres, while the remaining 85 percent of the total land area is occupied by only 33 farms. About half of the land in these 33 farms is contained in 5 farms exceeding 500 acres in size. Of the total number of farms in the area, 54 percent of those larger than 70 acres, 47 percent of the farms smaller than 70 acres and larger than 3 acres, and 94 percent of the farms smaller than 3 acres are operated by their owners.

Because of lack of rainfall or other adequate supplies of water, crop production in the area is limited. Most of the land, 83 percent, is devoted to pasture, and 13 percent is in corn, with 4 percent growing minor crops, vegetables, sugarcane, and tobacco. The value of crops for a recent 12-month period was estimated at \$107,960, of which \$79,540 was attributed to the harvest of corn.

The amount of land in pasture makes this a cattle area. The number of animals kept approximates 3,400 head, of which about 2,300 are milch

cows. The milch cows average only around 2.8 quarts of milk a day, and the annual output of milk is valued at \$135,000. The production of other animals and animal products is estimated at around \$60,000 a year. Some poultry is kept in the area, there being about 5,900 chickens.

With irrigation, the income from both crops and livestock could be increased. The irrigated land could produce sugarcane, vegetables, soilage and silage crops, millet, and various crops for feed. Crop value would probably be increased to 1½ million dollars for the area that could be irrigated. Dairy cattle and other livestock would benefit by irrigation and the value of livestock and livestock products would probably increase to \$380,000. The lands outside of the irrigated area could be used for such crops as possibly cotton, guineagrass, sesame, sunflower, improved pastures, and some fruits like papaya, avocado, and mango. Livestock such as beef cattle and work oxen and poultry could also be kept on these lands outside the irrigated area.

The capital outlay required for developing the engineering works, such as the water source and the necessary canals and ditches, is estimated at \$8,073,000. Over \$5,400,000 must be borne entirely by the irrigation feature of the project, and the rest of the capital required can be allotted to the power feature.

Considering the fact that at best irrigation would be available for only 4,800 acres of land, the share of the total cost of the project that would have to be borne by the irrigation feature raises a serious question as to whether the proposed undertaking is economically sound. The repayment ability of an irrigation system is contingent upon what the irrigator can afford to pay, and the rate varies widely in different irrigation systems. The principal factors influencing ability to pay are (a) the type of crop to be irrigated (b) the crop yield and gross revenues, (c) the cost of producing the crop, (d) the consumptive use of water, (e) the duty of water, and (f) the methods of financing the project works. Many of these factors, along with other minor considerations, are not subject to ready or accurate evaluation because of the indeterminable elements which may have considerable economic influence. For instance, a sharp drop in market returns from a crop or an unpredictable change in the cost of production will

obviously affect the amount which the irrigator can afford to pay for irrigation water.

The Public Irrigation Law, under which land already under irrigation in the south coast was first developed, provides a maximum water tax of \$15 per acre per year for the lands included in the irrigation district. Studies made in connection with the irrigation feature of the Southwestern Puerto Rico Project indicate that the irrigator can afford to pay \$28.75 per acre per year on lands planted to sugarcane. This is based on a duty of water of 5 acre-feet per acre per year. However, with other good lands already available to produce even more sugarcane than is now being grown on the island, and with quota limitations on the marketing of sugar, it is questionable whether this crop should be produced on land that may come under irrigation in the Coamo area. Yet, unless other crops that will result in a high per acre return are grown on this land, the irrigator's ability to pay for water may be decreased.

Taking into consideration all of the elements that influence the economics of agriculture, it seems appropriate to consider a maximum water tax of \$20 per acre per year for the lands to be irrigated in the Coamo area. On this basis, the estimated gross annual revenue from the service of irrigation water would be \$96,000 for the 4,800 acres. The operation and maintenance of the irrigation system is estimated to cost about \$36,000 per year, leaving a balance of \$60,000 for the payment of fixed capital charges. Capitalizing this amount at 4 percent for amortization and interest charges gives a total of \$1,500,000 which is the estimated capital investment that could be repaid from irrigation revenues.

Obviously, a substantial subsidy would be required from the Puerto Rican Government in order to operate the irrigation system proposed for the Coamo area. Out of the \$8,073,000 total capital investment that the project would require, an estimated \$4,110,000 could be repaid from the tangible benefits to be obtained from the irrigation and power features. The balance of \$3,913,000 would have to be supplied by the Government in the form of a subsidy and would have to be recovered from the public through taxation. This would not be too bad if the irrigation feature of the project resulted in benefits that at least equalled the cost of this subsidy. But in this particular case, with only

4,800 acres brought under irrigation at a cost of around \$1,125 per acre, the prospect of such a balance is very doubtful. Despite the fact that the land proposed for irrigation in the Coamo area would be well suited for crop production, the fact is that the cost of providing the water would be far too high. Present circumstances do not warrant the Puerto Rican Government putting in the amount of the subsidy that would be required. The proposed Coamo irrigation project should be held in abeyance until such time as the cost can be brought into reasonable balance with the benefits that would be derived from irrigating these lands.

Other Areas for Study

From the standpoint of meeting Puerto Rico's future needs for more land, no opportunity should be overlooked to reclaim areas that may be made more productive at a reasonable cost in relation to the possible benefits that may be derived. Altogether, there remain slightly over 107,200 acres which should be studied for possible reclamation. These include poorly drained soils, salty soils, and submerged land under the sea around the coast.

The area of land reclaimed by drainage in Puerto Rico up to 1951 totaled slightly over 7,340 acres at a total cost of \$484,776. The area of poorly drained soils which already has been studied is about 15,590 acres. A survey is needed to determine the feasibility of reclaiming about 32,400 acres of poorly drained soils. These include soils in an area of about 5,000 acres in the center of the Western Soil Conservation District just north of the Añasco River, 5,000 acres both west and east of the Loíza River, 400 acres of swamps at Colonia Santa Rita, Fajardo, 600 acres between Ceiba and Naguabo, and 2,000 acres at El Blandito, near Tortuguero, Vega Baja.

The 5,000 acres in the Añasco River area involve a serious drainage problem which embraces all phases of conservation work. In this section about 4,000 acres of valuable sugarcane lands are becoming less productive each year because of flooding and sedimentation from 1,000 acres of surrounding steep mountains. The mountains are almost without vegetation. All the topsoil has disappeared and the soils left are loose and very erosive. Each rain washes such large quantities of soil and rocks down the slopes that it is impossible to keep open the poorly located and poorly constructed drainage ditches on the cultivated flat-

land. The main outlet for the drainage to the sea is through artificial ditches and swamps which are constantly filled with soil. The mouth of this outlet is entirely blocked by sand deposited by the sea. This whole area deserves early attention and treatment by reclamation and soil conservation measures.

There are about 37,100 acres in Puerto Rico that have a salinity problem (table 34). Excluding the 10,481 acres of salty land in the Lajas Valley that have already been examined, about 26,619 acres of salty land should be studied to determine the possibilities of reclaiming them for agricultural use.

Table 34.—Area of saline soils in Puerto Rico that may be reclaimed

Soil series	Location	Acres
Cintrona.....	Ponce to Santa Isabel..	5, 120
Serrano.....	South Coast.....	9, 644
Teresa.....	Ponce to Aguirre.....	3, 968
Ursula.....	South Coast.....	1, 088
Aquirre and Guánica..	Lajas Valley.....	10, 481
Do.....	Ponce to Aguirre to Guamaní.....	4, 623
Fe.....	North Central Aguirre..	2, 176
Total.....	37, 100

The salty lands could be reclaimed by treatment such as washing the salts out with fresh water where irrigation is available with proper drainage, or by applying gypsum. Most of these salty lands have very fertile soils and are located in areas where irrigation would be available for growing crops on them.

There are about 40,000 acres of land submerged to a maximum depth of 15 feet along the coast of Puerto Rico. This submerged area offers a challenge in view of the fact that such land has been reclaimed successfully in other countries where land is scarce. For example, the Netherlands has extended by around 10 percent its cultivated area by reclaiming land from the bottom of the Zuider Zee from depths of 20 feet or less. The agronomic, engineering, and economic phases of reclaiming the submerged coastal lands of Puerto Rico deserve some study.

Puerto Rico has several lagoons that could be drained either for agricultural or real estate purposes. Drainage of some of these lagoons, however, would be detrimental to wildlife preserva-

tion, especially where birds use them as feeding and breeding areas.

The Guánica Lagoon with an estimated area of 1,123 acres and the Cartagena Lagoon with 251 acres, a total of 1,374 acres, are scheduled to be drained in connection with the Lajas Valley irrigation and development project. Drainage of the Cartagena Lagoon would be especially detrimental to wildlife since that lagoon and the surrounding area serve as the most important breeding ground for resident waterfowl and refuge for migrant water birds in all of Puerto Rico. This is definitely one area that should not be drained. Instead, it should be further developed as a bird refuge, preferably by the Puerto Rican Government.

Other lagoons that might be developed primarily for real estate purposes are located in the northern part of the island along the seacoast. These are the San José, Torrecilla, and Piñones lagoons which are to the north of Río Piedras and Carolina, and cover 144, 78, and 30 acres, respectively, or a total of 252 acres. Engineering studies made by the Puerto Rico Transportation Authority place the cost of reclaiming these lagoons at an estimated \$464,678, or \$1,804 per acre. The real estate value of this land when reclaimed is estimated at \$10,000 an acre, or \$2,520,000 for all of the 252 acres for real estate purposes.

Some time in the future Puerto Rico may be faced with the necessity of reclaiming those areas where it is not now economically feasible to do so. In any event, arrangements should be made and adequate funds provided by the Puerto Rican Government for a study that may well start soon to determine what portions of the areas that are now poorly drained, salty, or submerged lands could be reclaimed and at what cost. Since special equipment and experienced personnel are needed to collect soil samples from lands covered by sea water, the Insular Government should enlist the cooperation of the Bureau of Reclamation of the United States Department of the Interior in making a survey of the possibility of reclaiming agricultural land submerged in the shallow sea bottom around the coast of the island.

In reclamation projects undertaken with public funds to develop new land or provide irrigation water and drainage services that are publicly financed, a problem of land speculation usually appears as a result of the enhanced values arising

from the anticipated or actual improvements. These increases represent more or less of a wind-fall to the landowners since they probably would not occur without the expenditure of public funds for the particular project. That speculative transactions in unimproved land may exist when irrigation is to be provided, is indicated by the experience of the Federal Reclamation Service whose records disclose that on 25 projects aggregating 2,200,000 acres of land, the average increase in land values amounted to 750 percent. Some of the projects show increases up to 25 times the original land values.

The values of unimproved lands in Puerto Rico have also been increased by reclamation projects and the development of irrigation and drainage services that are publicly financed. The Southwestern Puerto Rico Project, for example, had a marked influence on land values in the area to be developed even before actual work was started. It is possible that as the project nears completion some of the unimproved lands of the Lajas Valley may increase from \$20 to \$600 per acre, or 30 times their value before the fact that the Puerto Rican Government would undertake the project became known. Where such a situation develops, it creates an unhealthy condition that could have a seriously adverse effect on the economics of the project and may even lead to harmful inflationary reaction throughout the project area. In early years the reclamation program of the Federal

Government was seriously hampered by speculative transactions in lands to be brought under irrigation or otherwise improved. This has since been overcome to a considerable extent by legislation that applies only to Federal reclamation projects.

If the publicly financed reclamation projects undertaken by the Puerto Rican Government are to be protected against land speculation, it will be necessary for Puerto Rico to have its own law for this purpose. The possibility of enacting such a law should be given immediate attention, especially in view of the scope and importance of the Southwestern Puerto Rico Project which has already been started to develop the lands of the Lajas Valley. The land enhancement values to be obtained by the development of those unimproved lands which constitute the net acreage of the irrigation district alone is estimated to amount to more than 7 million dollars. Since the Puerto Rican Government is contributing to the development of the sources of water, and thus making the irrigation project feasible, it follows that added values accruing from the land enhancement feature, so far as possible, should be returned to the Government, irrespective of land ownership. Certainly the public is entitled to this sort of protection; otherwise it will have to bear a burden of cost that results in the enrichment of a few at the expense of many.

Chapter IX

Agricultural Credit and Finance

Sometime the established money-lending institutions in Puerto Rico will fully wake up to the fact that there is more to agriculture on the island than the growing of sugarcane. When that happens they will realize what a large volume of good business has been either overlooked or neglected by them each year. Right now these lenders—private banks and Government-sponsored agencies—are meeting less than half of the agricultural production credit needs of the island. The big bulk of the credit that is available goes for the production of sugar. This situation exists even though the growing of sugarcane, as important as it is to the economy of Puerto Rico, supplies little more than half of the total value of farm production. And the great potential for further increasing that total lies in improving and expanding the production of other crops and of livestock and livestock products.

The lack of credit for almost any agricultural enterprise other than sugarcane has kept farmers from expanding existing farm operations or engaging in new production. For the most part, the legitimate lending agencies have not been interested in financing any of these other enterprises, largely because they knew more about the sugar industry than they did about any other phase of agriculture on the island. And lending money for the production of cane was traditional business. This long-standing lack of adequate sources of credit has forced many farmers to obtain their financing from merchants through advances of goods and materials. It has tied them to dealers-lenders and sugar mills or *centrals*. Some farmers even have been driven into the hands of loan sharks. And the cost of credit from these sources generally adds up to an inordinately high price.

Only about 30 percent of the farmers of Puerto Rico are able to obtain production credit from established lending agencies at reasonable rates of interest. About two-thirds of this volume of credit is supplied directly or indirectly by governmental agencies, and the remainder is furnished mostly by private banks. Another 30 percent of the farmers obtain their production financing from such sources as merchants and dealers, and the terms on which this credit is made available generally are unreasonable. The remaining 40 percent of the farmers do not have credit available to them from existing sources.

The lack of adequate credit has been traditionally one of the basic problems confronting the farmers of Puerto Rico. Credit for agricultural production, processing, and marketing has been deficient from the earliest days of the island's economic development even though some improvement has taken place since the 1920's.

When the growing of sugarcane was being promoted on the island during the 16th century, the Spanish Government encouraged development of this crop by offering some monetary assistance for its cultivation. The chief measure employed for stimulating expansion at that time, however, was the importation of slave labor. Credit was not available.

Early attempts to establish formal financial institutions started with the opening of an office by the London Colonial Bank in 1850. This bank supposedly discontinued business within 3 years. No records are available of its operations. Other attempts were made around 1847 to get a formal banking institution established on the island, but these met with failure because of the pressure of

prominent Spanish merchants who were the principal moneylenders at the time.

Later, attempts to establish formal banking institutions resulted in the chartering of the "La Sociedad Anónima de Crédito Mercantil" in 1877. This bank was the forerunner of the Spanish Bank of Puerto Rico, established in 1888, and in 1913 it became the Commercial Bank of Puerto Rico. Other banking institutions that opened were the Banco Territorial y Agrícola in 1894, Banco Popular in 1894, and Crédito y Ahorro Ponceno in 1895.

These banking institutions were, however, unable to supply credit to farmers. The sugarcane, tobacco, and coffee growers had to resort to the financing offered by merchants who provided the consumer goods needed by the farmers and their tenants. This later led to the financing of farmers by traders in farm products. The loans were secured by liens on the crops and, in some cases, by mortgages on the farms. The grower was obliged to deliver his products to the trader-lender. This often gave rise to usurious interest rates and abuses of the farmer. In many instances, foreclosure of these mortgages resulted in a shift of the land from the hands of farmers to those of traders. Merchants in the interior of the island became owners of most of the best coffee farms in Puerto Rico. Tobacco dealers also gradually increased their farm holdings with the result that many of them became the leading producers of tobacco in the areas where they operated. The same was true to some extent of sugar *centrals*.

In 1919, about 50 percent of the outstanding rural mortgage debt in Puerto Rico was owed to private individuals. Usually the amount of the loan was determined by the borrower's needs and the lender's willingness to offer the loan. No scientific appraisal of the property was made. In many cases, the earning capacity of the farm was overestimated. In other cases, the terms of the loan were too short for repayment from the farm.

One of the early attempts to establish a bank for serving agriculture was the passing of a law in 1913 providing for the establishment of a rural credit bank called the "Banco Insular de Puerto Rico." This bank was never organized in spite of the fact that subsequent legislatures (in 1916 and 1921) passed joint resolutions urging action in establishing this rural credit agency. The last

attempt was made in 1929 when another resolution was introduced, but it was not adopted.

Sources of Agricultural Financing

Up to 1921 the farmers of Puerto Rico depended almost wholly on individual lenders and merchants for their credit. The local banks dealt mainly with commercial concerns and paid scant attention to the credit needs of farmers. That year the United States Congress amended the Federal Farm Loan Act to include Puerto Rico, thus linking the island to the Federal agricultural credit system which was started in 1916. This authorization enabled the Federal Land Bank of Baltimore to establish an office in Puerto Rico in October 1922. It brought to the island lower-cost and longer-term financing for farmers who could qualify, and represented a very significant step in meeting the acute credit situation for those engaged in agriculture.

From the time this office opened until the end of June 1951, a total of 7,361 loans amounting to \$32,606,700 has been made in Puerto Rico. In addition, 1947 Land Bank Commissioner loans totaled \$4,843,300. At the end of December 1951, the Federal Land Bank had outstanding in Puerto Rico 2,900 loans totaling \$13,143,557. Land Bank Commissioner loans outstanding at the same time totaled 1,025 and amounted to \$1,210,575. The services and facilities originally provided by the Federal Land Bank on the island are now handled by the National Farm Loan Association of San Juan, organized in March 1950 following passage by Congress of an amendment to the Federal Farm Loan Act.

The second governmental agricultural credit facility that became available in Puerto Rico was the Federal Intermediate Credit Bank of Baltimore, which established an office on the island in 1925. This brought rediscounting facilities for short- and intermediate-term agricultural loans made by commercial banks, production credit associations, and cooperatives. From 1925 to 1950 discounts made by this bank totaled \$152,945,731.

In 1934 the provisions of the Federal Farm Credit Act of 1933 was extended to Puerto Rico by the Congress. Under this legislation the Production Credit Corporation of Baltimore started to set up production credit associations on the island. Nine local associations were established to make available to farmers short-term credit

through the rediscounting of their obligations with the Federal Intermediate Credit Bank. By August 1935, these nine associations were consolidated into one, the Puerto Rico Production Credit Association. This association has been a major factor in awakening local commercial banks to the fact that certain types of short-term agricultural credit constitute sound lending. Without doubt it has had a big influence in the improvement of credit for sugarcane growers. Many farmers who previously obtained their production credit from sugar *centrals* now rely on this association which is owned and controlled by the farmers themselves.

The volume of loans handled by the Puerto Rico Production Credit Association recently has ranged between 8 million and slightly over 10 million dollars annually. In the 5-year period 1946-47 through 1950-51, this association lent approximately \$46,877,400, or slightly more than \$9,375,000 on an average of about 1,525 loans annually. Of the total amount of money supplied during this 5-year period, 89.5 percent was in loans for sugarcane production, 2.25 percent for coffee, 5.5 percent for tobacco, 2 percent for livestock production, and 0.75 percent for other crops.

The Puerto Rico Production Credit Association has since its organization and up to the end of July 1951 made loans aggregating slightly more than \$83,451,000, and has sustained losses of only about \$2,000 in this entire period. This is a record worthy of the attention of the most conservative lenders.

Also in 1934, the Baltimore Bank for Cooperatives opened an office in Puerto Rico, bringing to the island an important source of credit to farmer cooperative associations. This made available to cooperatives loans for operating capital, commodity loans, and facility loans. Up to the end of June 1951, the Bank for Cooperatives had made net commitments exceeding \$36,125,000, made advances totaling \$33,510,000, received repayments and credits totaling a little more than \$32,239,000, and had current loans outstanding of slightly over \$1,270,000.

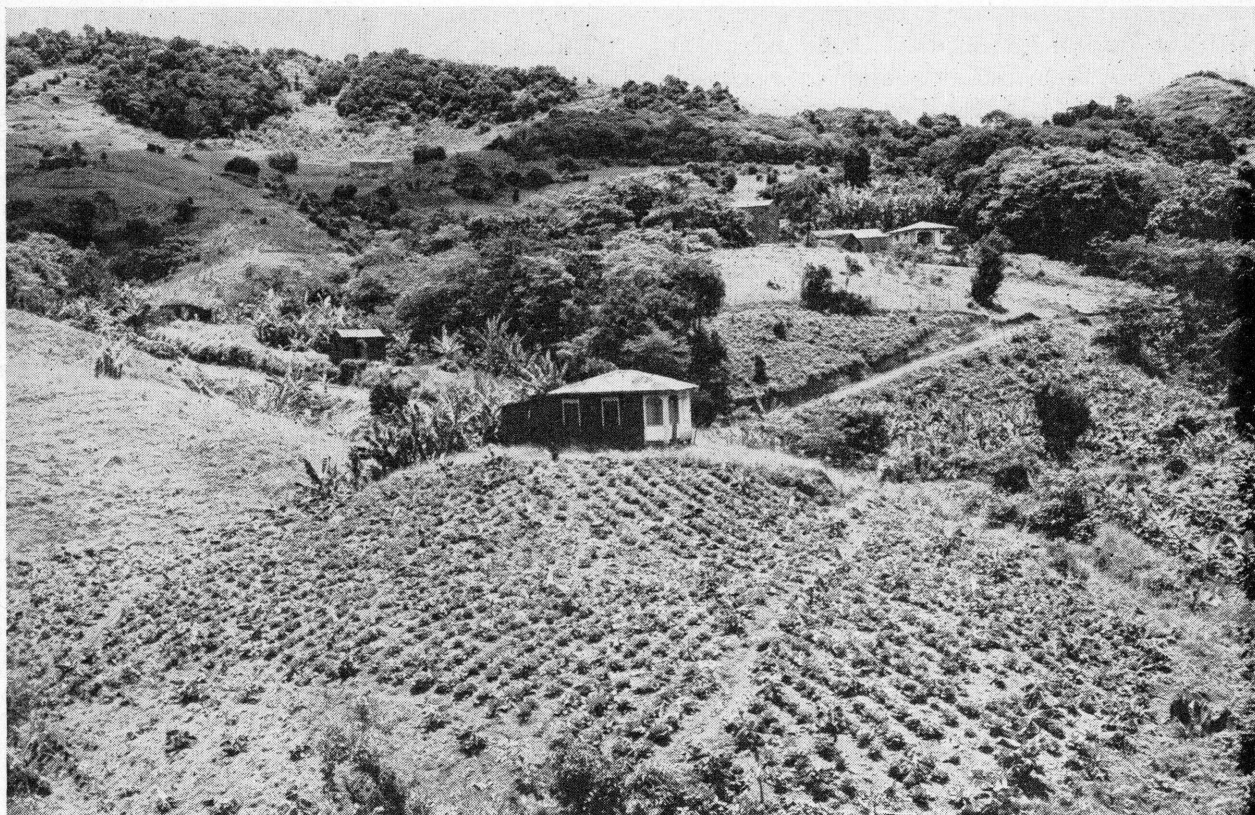
Another Federal agency, the Puerto Rico Reconstruction Administration, was established on the island in 1935. While this was an emergency agency for the reconstruction of the island following the disastrous effects of the 1932 depression, it exerted an influence on the agricultural economy in various ways. This agency made credit avail-

able for farm purchases, extended loans for farm production, and helped start and finance several cooperatives. The program of this agency was halted in 1941, and since then it has been in liquidation, with around 4 million dollars still to be collected as of the beginning of 1951. Of this amount, somewhat less than 3 million dollars was owed by cooperatives.

In March of 1935, a regional office of the Farm Credit Administration's Emergency Crop and Feed Loan Office was opened in Puerto Rico. The purpose was to make credit available to low-income farmers of the island who were not eligible for loans from the Production Credit Association or other sources at reasonable rates of interest. This agency was abolished in November 1946, and its functions were taken over by the Farmers Home Administration. From March 1935 to November 1946, the Emergency Crop and Feed Loan Office made 50,499 loans amounting to \$12,656,740. Its collection record was good. Of the loans made, 6,756 totaling \$3,078,963 were for coffee production, 17,664 totaling \$5,268,477 for sugarcane growing, 23,816 totaling \$3,427,025 for tobacco production, and 2,460 loans amounting to \$882,275 were for miscellaneous crops.

The Farmers Home Administration came into existence in August of 1946 when Congress abolished the Farm Security Administration and the Emergency Crop and Feed Loan Office and transferred all the assets, funds, contracts, property, records, and all liabilities of these two agencies to this new agency. The Farm Security Administration had been actively operating in Puerto Rico since 1941, providing credit and other assistance to low-income farm families. Up to October 1946, it had lent \$6,194,413 to these farm people. When the work of the Farm Security Administration and the Emergency Crop and Feed Loan Office was turned over to the Farmers Home Administration, this new agency was to continue to provide the services in Puerto Rico that had been received by a combined total of more than 20,000 low-income farm families.

The aim of the Farmers Home Administration is to provide supervised credit to eligible farmers for the acquisition, development, and operation of their farms when such credit is not available in the community on reasonable terms. Field supervisors of the agency work closely with the borrowers so as to help farm families become established



Small farms dot the Puerto Rican landscape. Many of them have so little land that their operators require additional employment. For all these small producers getting enough credit to grow a crop is a real problem.

on a basis that will allow them to make more effective use of their land and their labor. The supervisors assist borrowers in developing sound farm-and-home management plans. These chart the course along which the individual farm is to be operated and set the goals that are to be achieved. The supervisors also provide on-the-farm guidance. Borrowers are encouraged to adopt farming practices aimed at increased efficiency and a better utilization and conservation of land resources. In this connection, borrowers are stimulated to produce the highest amounts of subsistence crops for home use that can be produced without affecting their commercial cash enterprises.

Four credit programs are carried on by the Farmers Home Administration. These are the operating-loan program, the farm ownership program, the insured farm mortgage program, and the farm housing program. In addition, the agency can make disaster loans to farmers who suffer serious production losses because of flood, storm, drought, or some other natural disaster, and

who cannot obtain from other established local sources credit necessary to continue farming.

Under the operating-loan program, production and subsistence loans are made to farm operators for the purchase of livestock, equipment and farm supplies, for farm and home operating expenses, for land improvement and the adoption of agricultural conservation practices. Repayment schedules are generally consistent with expected income. Operating loans cannot exceed \$7,000, with a ceiling of \$10,000 on the indebtedness outstanding at any one time. The maximum repayment period for such loans is 7 years.

Most of the production and subsistence loans made to farmers in Puerto Rico are relatively small. In 1948-49, there were a total of 4,069 operating loans made by the Farmers Home Administration on the island and these amounted to \$1,654,290. The number of loans in 1949-50 totaled 4,268 and these amounted to \$1,941,585. In 1950-51 there were 4,972 loans and these totaled \$2,241,732. Altogether, from 1946 to the end of June 1951, the Farmers Home Administration ad-

vanced in Puerto Rico \$8,394,740 in production and subsistence loans. Of this total, \$5,842,204 has matured and this amount has been paid up to the extent of 99.7 percent plus \$319,795 in paid interest. Considering the fact that these production and subsistence loans are regarded in financial circles as "soft credit" and therefore very risky, this excellent record of repayment becomes all the more striking.

During 1950-51, the entire island of Puerto Rico was declared a disaster area as far as tobacco and coffee crops were concerned. A total of \$557,420 was made available for disaster loans. The regular funds available for the operating-loan program in Puerto Rico totaled \$1,740,000 for the 1950-51 fiscal year. The amount of money allocated to the island for operating loans is far below the actual needs of farmers who otherwise cannot obtain credit on a reasonable basis. Many more farmers could be soundly helped with their credit requirements if the Farmers Home Administration office in Puerto Rico had the money available to lend. And in making more operating loans, the agency would be taking no greater risk than it now assumes since all of the loans necessarily would be on the same basis.

Under the farm ownership program, the Farmers Home Administration makes loans for the purchase, enlargement, or development of family-type farms. The number of such loans made in Puerto Rico in recent years has been quite limited, mainly because of restrictions brought about by a preference-for-veterans requirement. In 1948-49 there were 25 farm ownership loans made and these totaled \$144,606. Farm ownership loans in 1949-50 totaled 41 and amounted to \$316,797. The number of loans dropped to nine in 1950-51 and amounted to only \$48,822 in spite of the fact that the total sum of money available for such loans on the island was \$525,894 for that year. Since 1937, when these farm ownership loans were first authorized under the Bankhead-Jones Farm Tenant Act, the amount lent in Puerto Rico from Federal funds through the end of June 1951 totaled \$4,174,032. Payments on the principal totaled \$1,503,979 and interest paid on the loan advances amounted to \$673,604. Of the total of \$2,177,583 in principal and interest payments, \$960,748 represented extra payments or refunds made by borrowers up to the end of June 1951.

The insured farm mortgage program operates in addition to the direct loans for family-type farm purchases. This insurance authority was provided to the Farmers Home Administration by legislation enacted in 1947. Insured farm mortgage loans are made to qualified applicants who have the necessary experience in farming to help them buy and improve family-type farms, or to buy additional land to enlarge their farms. Such loans are made only to eligible farmers who are unable to obtain necessary financing from private sources such as banks or insurance companies on such terms and at such interest rates as they may reasonably be expected to repay. The borrower is required to make a 10 percent down payment from his own funds if he buys a farm, or to have a 10 percent equity in a farm that he already owns. Thus, the loan which is insured cannot exceed 90 percent of the value of the farm as improved.

The Farmers Home Administration's county committee which passes on all loan applications, must also pass upon the eligibility and responsibility of the applicant for an insured loan and upon the adequacy and value of the farm. The security must be appraised by a qualified appraiser of the Farmers Home Administration. The value of the security is based on the earning capacity of the farm, figured on long-time average prices for farm commodities and on average yields. Final approval of the loan is the responsibility of the Farmers Home Administration.

The borrower under an insured loan pays annually 3 percent interest on the unpaid amount of the principal. In addition, the borrower pays a 1 percent annual mortgage-insurance charge to the Farmers Home Administration. Loans are amortized over a 40-year period. Borrowers have the privilege of repaying the loans under a variable payment plan which permits them to build up reserves in years of good income to keep their loans in good standing during years of low income. Loans must be refinanced whenever the borrower achieves sufficient equity to enable him to obtain satisfactory credit without the benefit of insurance.

The loans under this program are fully insured by the Federal Government both as to the principal and interest. If an installment is not paid by the borrower, the Farmers Home Administration promptly pays the lender the amount due. If foreclosure appears necessary, the Farmers

Home Administration takes an assignment of the note and mortgage and pays the lender the value of the mortgage at the time the assignment is made. All loan-making and loan-servicing functions are handled by the Farmers Home Administration.

The insured mortgages are readily negotiable; they can easily be assigned by one lender to another at any time. Whereas the loans are made for 40 years, at the end of the seventh year the lender may assign the mortgage to the Federal Government and receive in cash its full value, or the lender may enter into an agreement with the Government for an additional fixed period or keep this investment until such time as the borrower can refinance or pay the loan in full.

In many parts of the United States, the insured farm mortgage loans are proving attractive as a safe investment for private lenders. Some States found it was necessary to enact enabling legislation to permit investors, such as banks, insurance companies, and others, to make investments in this kind of security. One of these was New York State, where the necessary legislation was enacted in 1949. Federal law already provides that these insured mortgages are eligible investments for national banks. In the 4 years since the beginning of the farm mortgage insurance program in 1947, loans approximating 45 million dollars were insured by the Farmers Home Administration. These loans were made by 652 banks, 44 insurance companies, and various other types of investors. The largest amount of insured mortgage loans held by one investor, an insurance company, amounted to over 7 million dollars; the largest held by a single bank was \$1,300,000.

Banks and other private lending institutions operating in Puerto Rico have been slow to participate in the farm mortgage insurance program. One obstacle in the way until the early part of 1951 was that the laws of the Puerto Rican Government made investments in these mortgages on the island unattractive to lending agencies. In May 1951 the local Legislature amended the statutes so as to exempt from income tax the interest earned on mortgages insured by the Farmers Home Administration. This should provide an incentive for private banks and other lenders to invest in this kind of loan.

Under the farm housing program the Farmers Home Administration makes loans for the con-

struction of new farmhouses, and for remodeling or repairing existing dwellings. The loans are also available for the construction or repair of farm buildings. All construction work must meet minimum standards set by the agency. This particular program was authorized by the Housing Act of 1949. In Puerto Rico 85 loans, totaling \$314,735, were made under the program in 1949-50. There were 86 loans amounting to \$345,151 made in 1950-51.

An additional source of credit for farmers in Puerto Rico is provided by the Commodity Credit Corporation, which makes commodity loans in connection with price-support operations of the Production and Marketing Administration. This agency has been extremely helpful to tobacco growers on the island, making loans on this commodity beginning with the 1946-47 crop with tobacco pledged as collateral for the price-support loans. Up to the end of June 1951 the Commodity Credit Corporation had made price-support loans to growers in Puerto Rico on 42,478,511 pounds of tobacco, green-weight basis. The money lent on this tobacco amounted to \$15,353,705.75. The inventory of tobacco held at the end of June 1951 totaled 2,829,081 pounds, dry weight, and outstanding loans amounted to \$1,057,918.04. Most of the tobacco loans are made to growers through cooperatives. The availability of the loan from the Commodity Credit Corporation enables participating growers to market their tobacco in a more orderly fashion. Before the loan program was available many of these growers were forced to sell their crop soon after harvest in order to get some cash with which to pay their bills.

Despite the various sources of credit for agriculture made available by the Federal Government, a big gap remains to be filled. These Federal agencies, as helpful as they are, only partly meet the agricultural credit needs in Puerto Rico. Recognizing the existence of this situation, the Puerto Rican Government has attempted to provide some help in financing farmers.

One measure that has been taken is designed to assist the small producers to increase food production and improve its distribution. This food production and distribution program is sponsored by the Puerto Rican Department of Agriculture. Although this program operates with very limited funds, it provides credit in kind to the type of farmers in most need of it, those engaged in the

production of food crops. For the most part, the program operates through cooperatives. Equipment and supplies are sold on credit to farmer cooperatives and these participating organizations lend them out to farmer members. The program also provides for purchases of farm products produced by members of cooperatives. In addition, provision is made for the sale on credit of equipment necessary for grading and packing certain food products. Technical assistance is also provided to cooperatives and individual farmers.

The most important action yet taken by the Puerto Rican Government in providing agricultural credit was in 1951, when the Puerto Rico Bank for Cooperatives was established. This bank was authorized by the local law to make the following types of loans to cooperatives: (1) Operating capital loans for terms up to 2 years; (2) crop production loans for terms not exceeding 2 years to be made to cooperatives for financing their members' crops; (3) middle-term loans for equipment for periods up to 5 years; and (4) loans for land and buildings for terms up to 10 years.

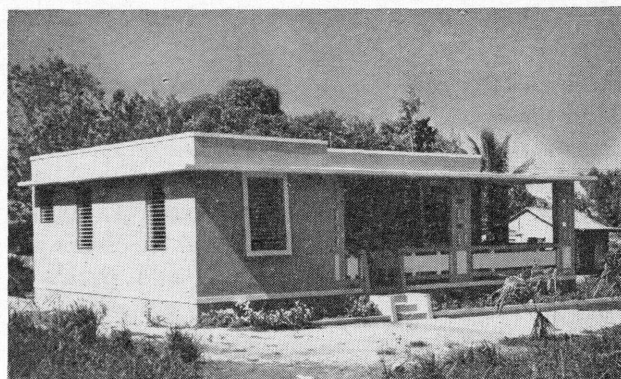
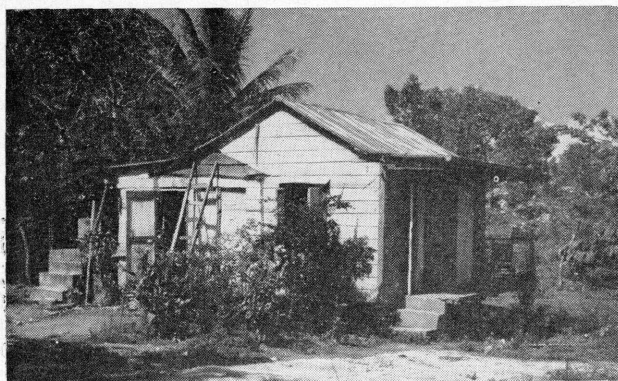
The Puerto Rico Bank for Cooperatives operates as an instrumentality of the local Government. It is capitalized at 1 million dollars. Under the original provisions of law not more than 10 percent of the bank's capital and surplus may be lent to any one cooperative. This restriction on loans and the limited capital structure may need to be modified in order to permit the bank to function more effectively. Nevertheless, the existence of this bank offers a good opportunity for further improving the agricultural credit situation in Puerto Rico.

Governmental credit agencies, especially those sponsored by the Federal Government, have played a major role in improving the credit situation for farmers since they first began operating in Puerto Rico in 1922. These institutions pioneered in a field virtually untouched by private banks and other established credit agencies. Only in relatively recent years have these private lending agencies engaged in making agricultural loans in any significant amounts. The volume of crop production loans made by 10 banks operating in Puerto Rico rose to a level estimated at 25 million to 30 million dollars a year. A very small percentage of this money is lent for crops other

than sugarcane. In some cases the loans are made to sugar *centrals*, which in turn make loans to their *colonos*, or growers. Part of this credit is used by the *centrals* to finance growing of their own cane. Quite recently two of the banks have opened branches in several agricultural areas and are making short-term production loans. They are performing a good short-term credit service for sugarcane producers, and are even financing some small producers. On the whole, however, credit is still very limited for farmers other than sugarcane producers.

But the fact that the private banks of Puerto Rico are paying more attention to the credit needs of farmers is encouraging for future agricultural development. However, this change is not coming along rapidly enough. For years the agencies of the Federal Government have been the major source of credit for agriculture in Puerto Rico when much of this business could have been profitably handled by the locally established credit institutions if they had only been willing to take it on. Even today the Federal credit agencies would welcome losing this business to the private banks and other established lenders if this meant improved service to farmers. In any event, the Federal agricultural credit agencies are limited in the funds at their disposal, and they have not been able to meet all of the demand for loans from sound credit risks on the island. In such a situation the private lending establishments have a broad field in which to operate for the benefit of themselves as well as of the individual farm borrower and the economy of which they are a part.

Government sponsored credit agencies such as the Production Credit Association, and especially the Farmers Home Administration with its highly diversified lending program, have done much to pave the way for sound agricultural financing in Puerto Rico. Their collection experience with loans to farmers on the island has been so good that it is hard to understand why private lending establishments such as banks have not been more aggressive in making loans to local farmers. Admittedly, agricultural credit is more or less a specialized field which requires some knowledge of the nature of the risks to be taken. But this requirement is not insurmountable, as is demonstrated by the experience of banks operating in agricultural communities on the mainland.



The old and the new: A farm housing loan made the difference.

Through efforts in the last few years, some progress is being made in broadening the interest bankers in Puerto Rico have in the agriculture of the island. For example, a bankers' agricultural committee was first organized in 1950. This group includes representatives of all the banks operating on the island and provides opportunities for the discussion of agricultural problems and developing a better understanding of the important farm segment of the economy. As a result, there has been some increase in loans made by banks to farmers other than sugarcane growers. But still the surface has hardly been scratched, despite the opportunity that exists for rendering greater service to the agriculture of Puerto Rico while making a reasonable profit in the process.

The fact that lack of credit has been and still is a major factor retarding the development of agriculture in Puerto Rico is now being generally recognized. Action is needed to make more credit available at reasonable cost for the many agricultural enterprises that should be encouraged on an economically sound basis. If the existing credit agencies, both private and government sponsored, do not become more aggressive in meeting the sound financing needs of Puerto Rican agriculture, then the farmers will have no choice but to develop other sources of credit with still more governmental help and by the pooling of their own resources.

Interest Rates and Credit Costs

Historically, Puerto Rico has been a high-interest-rate area. Before the agricultural credit agencies of the Federal Government were made available to the island, coffee growers and other farmers depended almost exclusively on store

credit, and the financing merchants advanced goods and money to the growers on the promise of their future crop. The goods given to coffee farmers were charged at exceedingly high prices and the money was advanced at very high interest. There is some evidence of interest rates having been as high as 30 percent. That the interest was high can be substantiated in part at least by the great number of foreclosures and the shift of the land into the hands of big merchants. What was true of merchants was also true of dealers who financed production. Much of this form of financing still prevails.

A similar situation existed in tobacco. The dealers financed the tobacco crop of the farmers on the security of both the crop and the farm. Many tobacco dealers eventually became big landholders. Large numbers of tobacco growers still are at the mercy of the dealer-lenders. When the farmer brings his crop to such a dealer, there is no bargaining. The farmer lost his bargaining power when he became indebted to the dealer by the advance of money with which to make the crop. In most cases the grower gets a lower return for the crop, with resultant usurious rates of interest for the credit obtained.

And growers of sugarcane also were tied down by the loans they obtained for production. For a long time the *centrals* and the large *colonos* were the only sources of credit. Despite the improvement that has taken place during the last three decades in the availability of financing for sugarcane production, they still are the only sources of credit for many of the growers.

The Federal agricultural lending agencies operating in Puerto Rico since 1922 have been a most important factor in bringing interest rates down.

They set the pace in providing credit on reasonable terms, and demonstrated that farmers generally were good credit risks. Gradually the banks became interested in the farm credit business, thus increasing sources of credit for farmers. The interest rates charged by the banks tended to follow the pattern set by the Federal lending agencies. And while all these developments meant a lower cost of credit for farmers who could borrow from these sources, the number of producers served was comparatively few at the start although the total has been rising in more recent years. Nevertheless, there are still many tobacco, coffee, sugarcane producers, and other farmers paying usurious interest rates for the credit they are able to get only from other than established lending agencies. Moreover, most farmers are unable to get credit from any source for farm improvements or diversified production that could be made profitable. For these farmers the lack of credit is costly, indeed, not only to themselves, but also to the economy.

Financial institutions subject to the jurisdiction of the Puerto Rican Government are limited by law as to the amount of interest they can charge on loans. The lawful rate that may be charged on a loan or upon any variety of obligation or contract, in the absence of a written agreement, is 6 percent. Where a written agreement does exist, the interest rate cannot go beyond 9 percent when the amount of the loan is not over \$3,000, and 8 percent when the amount exceeds that figure. Legislation enacted in 1948 provides penalties for violations of lawful rates of interest by all classes of moneylenders.

While no detailed study of the cost of credit has been made since the beginning of World War II, an indication of the conditions that have prevailed is available from two credit studies made in 1939-40 by the Puerto Rican Agricultural Experiment Station, one covering sugarcane farms and the other tobacco farms.

The study on sugarcane farms revealed that sugar *centrals* were by far the most important source of sugarcane production credit. Even with the expansion of credit facilities by Federal agencies and local banks, these sugar mills still supply a big part of the credit for growing sugarcane on the island.

At the time of the study made by the Experiment Station, the effective interest rate charged

by sugar *centrals* was 8.35 percent. Large *colonos*, which at this time constituted the second most important source of credit, charged 16.52 percent. The cost of credit for sugarcane farmers charged by the Production Credit Association was 9.72 percent. The lowest interest rate was charged by the Emergency Crop and Feed Loan Office, that being 5.1 percent. Even though the nominal interest rate was lower in all cases, legal and supervisory fees increased these costs to the figures found to prevail.

The study covering tobacco farms revealed that the credit costs on tobacco loans involved direct interest costs, and indirect interest costs. The direct costs included interest, legal expenses, and other credit expenses which could be charged clearly to the farmer in his liquidation papers. Indirect costs could come in many ways, especially in the form of a lower price for the tobacco or higher price for fertilizer and other materials included in the loan.

This study showed that the direct costs of loans from the Puerto Rico Tobacco Marketing Cooperative Association totaled 5.44 percent and those from dealer-lenders amounted to 7.04 percent. Problems encountered in analyzing the data of this study made it impossible to arrive at definite conclusions on the indirect costs of credit. The study revealed, however, that there were indications that higher prices for materials were charged to the



Stripping tobacco is a hand operation that provides employment for a large number of Puerto Rican women.

farmers dealing with the dealer-lenders. And these farmers who delivered their tobacco to the dealer-lenders received a lower return from their crop.

Dealer-lenders supply the tobacco production credit needs of the largest number of farmers on the island. It is obvious that the system utilized by them lends itself to the charging of very high interest rates. Many of the dealer-lenders are in fact what might be termed credit retailers. They borrow money from local banks and retail the money to farmers. In their retail of credit, they charge 3 to 4 percent additional interest. This is only the nominal interest rate since they make a number of additional charges, both direct and indirect.

There are a number of coffee dealer-lenders who operate on a different basis. Since coffee prices are fixed by the Puerto Rican Government, they have devised other means of making additional charges. One group of coffee dealers, for example, charges 8 to 9 percent nominal interest on the loans made to growers. In addition, these dealers charge a commission of 5 percent for the sale of the coffee, plus a charge of \$1 for each 100 pounds of coffee handled. In most cases, charges are made for redrying the coffee. Coffee dealer-lenders in this class borrow their money from local banks on the security of crop liens and coffee crop insurance endorsements handed to them by their farmer clients. Most of the farmers who do business with this type of dealer-lender lack information and education. Many of them could get their credit directly from banks if they knew where to go and what to do. Others are small growers and most banks would not be interested in them.

Amount of Credit Required

There is no doubt that the farmers of Puerto Rico are handicapped by the lack of adequate credit from sources that are in position to make financing available at a reasonable cost. However, the width of the gap that exists between the amount of credit these farmers need and what they are actually able to get is not so clear cut. But there are certain known factors relating to production, farm income, and credit already being extended that make it possible to do some reasonable estimating without going into a detailed and exhaustive study of the subject. An estimate on this basis indicates that the farmers of the island

need each year between 90 million and 100 million dollars for production credit alone. This represents the volume of credit that could be extended by recognized lending agencies for sound investments in agricultural production.

Out of the total estimated as needed, the amount of production credit now being supplied by these lending agencies such as private banks, the Production Credit Association, and various governmental sources is around 44 million dollars. This leaves a gap of at least 46 million dollars for the legitimate lending institutions to fill. While part of this 46 million dollars is now being supplied by merchants, dealers, and other such lenders, it nevertheless represents business that could very well be taken up by the regular credit agencies with profit to themselves and substantial savings to the farmers who now must depend on miscellaneous sources. The balance remaining in this credit gap that should be filled by the recognized lending agencies would represent entirely new business simply because the needs are not now being satisfied.

Breaking down the estimated total production credit requirements and the part of those needs that is being met, the situation existing in the major agricultural enterprises appears as follows:

In the case of sugarcane production, it is estimated that total credit needs for growing this crop approximates 52 million dollars. Even though there are many small growers who are not getting enough credit, thus reducing their efficiency, credit for sugarcane production is, for all practical purposes, fairly well covered. There is need, however, for a shift in sources of credit that growers could make with savings in cost.

Of the 52 million dollars estimated as being required to meet the credit needs of sugarcane producers, slightly more than 36 million dollars is being supplied by established lending agencies, mostly by the private banks. In 1949-50, for example, 10 banks made loans totaling 26 million dollars for sugarcane production. Part of this credit went to sugar *centrals* which reloaned the money to their *colonos*. The sugar mills are presently the most important sources of credit to their producers. Another important source of financing for sugarcane growers is the Production Credit Association with around 9 million dollars. The Farmers Home Administration covers the needs

of some of the small growers to an estimated amount of \$1,250,000.

A more recent lending source is a credit co-operative organized among the producer members of Cooperative Azucarera Los Caños at Arecibo, a cooperatively owned sugar mill, which supplies around \$200,000 in loans to small growers. The rest of the credit supplied for sugarcane is at present being covered by sugar mills, large *colonos*, fertilizer dealers, and others. The cost of the credit from these sources is usually higher than from established lending agencies. Growers would benefit considerably if these institutions would handle this business directly with them.

Tobacco presents a different picture. Most of the tobacco growers need credit for the production of their crop, but very few of them are able to get it from established lending sources. The total amount of credit needed by these farmers is estimated at between 6 million and 7 million dollars, depending upon the acreage to be grown in any one year. Only 25 percent of the credit is obtained at a reasonable cost and this comes from banks, governmental agencies, and cooperatives. The balance is furnished largely by tobacco dealers at an extremely high cost which in many cases constitutes a usurious rate of interest.

Coffee is the most poorly financed of the major crops in Puerto Rico at the present time. Yet this crop is vital to the economic and physical welfare of a large area of the interior mountainous region. The present situation, although it is improving, stems from earlier credit experience in which not too much care was taken in making the loans. In the past, coffee farmers were heavily financed with long-term loans, especially after the hurricane of 1928 when much credit was extended by the Puerto Rico Hurricane Relief Commission. A large number of coffee growers received long-term credit and in many cases the loans were over and above the ability of the borrower to repay. There were some cases where the loans were not entirely invested in the improvement of the farms. The unhappy experiences with these past loans were due primarily to poor selection of credit risks, the failure to make sure that the borrowers understood the purpose of the loans, and the lack of supervision.

The coffee growers have recently been engaged in a program for the rehabilitation of their coffee plantations, and considerable progress is being

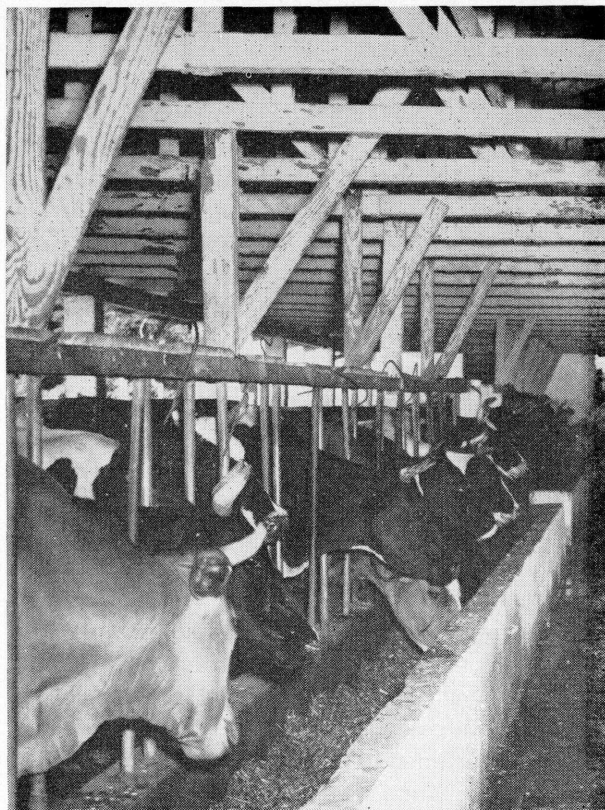
made toward conserving soil resources and increasing production through the adoption of improved management and cultural practices. This activity is made possible by the cooperation of the various agricultural agencies of the Puerto Rican and Federal Governments. In this unified program for the rehabilitation of the coffee industry, growers receive payments from Puerto Rican and Federal funds for the application of certain approved practices such as the building of necessary terraces around the coffee trees to provide needed protection against runoff, use of fertilizer, and some others. These payments help reimburse the grower for part of his cash expenditure and provide an incentive for undertaking work which he otherwise could not afford to do in view of the low production from unimproved plantations. These payments are to be discontinued when the plantations are improved and production is up to a point where the grower is able to follow the desirable practices without any Government payments. An estimated 10,000 coffee growers are participating in this program, and payments during 1950-51 totaled slightly in excess of 1 million dollars, of which a little over half came from Federal funds supplied under the Agricultural Conservation Program of the United States Department of Agriculture. Most of the coffee producers are small farmers.

The payments under the unified coffee program are of real help, since they provide funds which most growers could not obtain because of the lack of credit. With this money in view, participating farmers have been able to buy more nearly the quantities of fertilizer required for the acreage included under the program. These farmers apply for the payment to the Production and Marketing Administration and this agency issues a purchase order for the amount of fertilizer needed in which it guarantees the sellers of the fertilizer the amount of the payment represented on the order. With these purchase orders farmers are able to get credit from their fertilizer suppliers. Actual payment on the orders and for other practices is made by the Production and Marketing Administration after an inspection to determine performance of the practices and the application of the fertilizer on the acreage included under the program by the participating farmers. During 1950-51 fertilizer purchase orders issued amounted to \$449,000.

With the material improvement being made in the plantations under the unified coffee program and the substantial effect this is having on increasing yields, it is estimated that coffee growers need 9 million dollars in production credit in order to realize the present potential of their industry. Of this amount, they are getting only about \$3,500,000 in loans from established credit sources and in payments under the unified coffee program. Part of the remaining needs is no doubt supplied by dealer-lenders, merchants, large growers, and other such sources from which credit is usually costly to the farmer. It is a fact, however, that the largest number of coffee farmers are unable to obtain production credit, and only a very few get enough to meet their requirements. That credit to coffee growers is wholly inadequate is evidenced by the fact that during the harvest season many growers are compelled to sell their coffee half dry and at a sacrifice price in order to obtain money to continue harvesting their crop.

Private banks, the Production Credit Association, and Federal lending agencies are making far more credit available to coffee growers than they have in many years. During 1950-51 these institutions advanced around \$2,000,000, or between three and four times the average lendings in the previous 5 years. One factor contributing to this increase in credit has, of course, been the unified coffee program which is bringing about a considerable improvement in both the plantations and yields. Another and very important factor, however, is the coffee-crop insurance program which is operated by the Puerto Rican Government. All of the growers who obtained loans from the established lending agencies carried coffee-crop insurance which was endorsed to their sources of credit. Other lenders who advanced growers nearly \$500,000 required farmers to do the same. With the increase in the number of farmers buying crop insurance, it is possible that more credit from established lending institutions will be extended for coffee production. This development could be facilitated by the establishment of closer working relationships between the insular agency handling the crop-insurance program and these various sources of credit.

Livestock and dairying combined is the second major agricultural enterprise in Puerto Rico. Livestock raising has been connected with the sugarcane industry for many years. Sugarcane



Dairy cattle relish green cut grass, especially when sprinkled with a little molasses which is readily available in Puerto Rico and also adds to the nutritional value.

culture has depended on oxen for cultivation and hauling. Cattle have been kept mainly for raising the oxen. Large landholders grew their sugarcane in the lowlands and also used the hilly land as pasture for their livestock. Some of the large landholders of the southern coast also kept dairies in connection with the livestock-raising enterprise. Part of their stock was sold for meat.

As time went on and purebred stock was imported from the United States, these southern coast dairies imported bulls and cows and improved their dairy animals. In many of these dairies, however, Brahma blood is strong, since this was essential for oxen. Other small dairies were also established along the southern coast, but also in connection with sugarcane or other agricultural enterprises. Thus, credit for livestock and dairying was not obtained directly, but in combination with credit for sugarcane. This dairy industry of the southern coast is very extensive and production per cow is very low. Where dairying is predominant on a small farm, the

farmer in many cases is dependent on usurious credit to finance his operations. No doubt that lack of credit has hindered the establishment of many family-type dairies in the southern and western coasts, and also in the hilly sections of the island. The impact of mechanization is gradually eliminating the oxen in favor of mechanical equipment in the sugarcane industry. Adequate credit for dairying would result in good utilization of the land formerly devoted to pasturing oxen. It would also greatly improve the use of much other land in the hilly regions.

The dairy industry all around the island has lacked adequate credit. An important source of financing for dairy farmers has been the feed dealers. This very inefficient type of credit is probably the major source available to dairymen. Other sources of financing have paid very little attention to the dairy industry, which has possibilities for great expansion to supply the milk and meat so much needed on the island. But if the dairy industry is to be improved, credit must be available at reasonable cost for the purchase of higher producing animals, as well as for establishing and improving pastures, building silos and barns, and for supplies and equipment needed in dairy production.

An expansion in livestock and dairying that will make the most effective use of the grassland resources that are available will require quite an investment over the years. Around 10 million dollars will be needed for dairy animals alone. The improvement of pastures and forage crop production to provide more feed at a lower cost will require an investment of from 15 million to 20 million dollars if all of the suitable grasslands are to be effectively utilized. Around 10 million dollars will be required for the construction of necessary barns and silos, and for equipment and other production essentials. Altogether, between 30 million and 40 million dollars would be needed over the years, and such an investment would more than double the production of milk and greatly increase meat supplies. This would reduce by more than half the quantity of animal products now being imported. The value of these imports alone is around 40 million dollars a year.

But the investment needed to bring about a healthy and economically desirable expansion in livestock and dairying on the island would not have to be made in too great amounts in any one

year. The money could be invested through a period of 10 years so that the annual outlay of 3 million or 4 million dollars in additional capital would be necessary over a decade. Large and small farmers should be able to participate in such an expansion, and proper guidance should be made available to them so as to insure the best results.

At the present time it is estimated that the livestock and dairy industry of Puerto Rico needs 12 million dollars in production credit. More will be required as dairying expands. Most of the credit needed to buy feed is now supplied by the feed dealers. Other sources supply credit for the purchase of livestock and other requirements. Loans for livestock made by the Production Credit Association during 1950-51 amounted to only \$396,170. The Farmers Home Administration also made some loans for livestock under its operating-loan program. But the funds of this agency are limited. Very few loans are made by banks for livestock purposes.

The poultry industry has developed considerably in Puerto Rico since the end of World War II. The growth has been mainly in the raising of purchased chicks for meat purposes. This development has taken place mainly in or near the San Juan metropolitan area. Most of the credit obtainable for poultry production is from feed dealers. Very little financing is available from other sources. The Production Credit Association made loans totaling only \$54,000 during 1950-51. Poultry and egg production have good possibilities on the island, but there are only a few farmers engaged in this business, although a few chickens, mainly of native stock, are kept on most farms. Imports of eggs and poultry meat total around 3 million dollars a year. Small and medium-size farm flocks and commercial poultry enterprises should be encouraged on the island, but coupled with this there would have to be additional credit and also an improvement in marketing facilities to handle the products for the producers. The present credit needs of the poultry industry are estimated at around 2 million dollars, and more could be profitably used if expansion takes place.

Pineapple production could be increased substantially in Puerto Rico. This industry has been making considerable progress recently in improving the quality of its product, and good market outlets are being developed on the mainland. To

grow the crop requires a large investment per acre. Because of the lack of credit and adequate marketing facilities, most of the production is in the hands of a very few large growers who are in position to finance their own production and marketing operations. Loans made by the Production Credit Association and other agencies have been very limited. There is need for an industry-wide organization to handle the processing and marketing functions more efficiently and provide a ready channel through which individual growers could sell their pineapple after it is produced. A well organized marketing system should help improve credit for pineapple growers. Production credit requirements for pineapple are estimated at around 3 million dollars. This level would permit some further expansion from the recently prevailing acreage.

The production of long-staple cotton could become more significant in Puerto Rico if growers improved their production practices and had the necessary credit available to finance growing of this crop. Cotton production on the island has been quite irregular, the acreage varying from less than 2,000 acres to over 10,000 acres in the 1940-50 period. The cotton is usually grown intercropped with food crops. In 1950-51 the acreage of cotton totaled around 3,800 acres. Fertilizer is used on only about half the acreage, and poor practices in production result in low yields. One main reason for this situation is the lack of production credit. Only a small amount of financing is done by the Farmers Home Administration. The bulk of the cotton production is handled by the Puerto Rico Cotton Growers Marketing Cooperative Association.

In addition to cotton, there are crops such as starchy and other vegetables, grains and cereals, oil and fiber-producing plants, ornamental plants and flowers, and plantains, bananas, avocados, mangoes, and other fruits for which production credit is almost unavailable. Recently, the Puerto Rican Government has attempted to deal with part of this problem by making some financing available to small farmers under its food production and distribution program. Many of these crops are of considerable commercial importance, but their development is held down by the serious lack of financing and the inadequacy of existing marketing facilities. It is estimated that 5 million

dollars would be required to meet the production credit needs of the producers of cotton and all these other crops that are commercially important.

Ways to Improve Credit Sources

The existing credit mechanism in Puerto Rico is not geared to provide the financing needed by most farmers. In general, all that the farmers can get under the conditions that prevail is short-term production credit and the amount of this is very limited except for the growing of sugarcane. Hardly any credit is available from established lending agencies for the purchase of farm machinery and equipment, and to make necessary farm improvements. The Farmers Home Administration has helped some in financing such activities which require longer-term loans, but the amount of money available to it has been very restricted. Various other governmental agencies have financed cooperatives which in turn make loans or advances to their members, but these also have been more or less limited. The private banks and the Production Credit Association have their attention focused on credit for sugarcane, and most other sound agricultural financing possibilities are being overlooked. This entire situation presents a problem of great magnitude. It indicates the need for a reexamination of lending policies by all of the private and governmental lending institutions as well as a reappraisal of the adequacy of the credit facilities that are available to agriculture on the island.

There is far too little credit available in Puerto Rico to provide the financial means for the kind of diversification of agricultural production required as to make the most effective use of the productive resources and meet the needs of the people. Too much credit is not desirable—in fact it can be dangerous—but the right amount of credit kept in balance with the reasonable needs for good maintenance, proper expansion, and sound growth of agricultural enterprises can be very constructive.

The generally conservative and ultraconservative agricultural lending policies being followed by the established financial institutions in Puerto Rico do not fill the requirements of an adequate credit system. The inclination is to play it safe with the known, and little or no effort is made to become familiar with the unknown. This is one reason why credit from these sources has been so

readily available for sugarcane growing with hardly any for other farm enterprises.

Agricultural credit is, of course, a highly specialized field. It requires a well-grounded and broad understanding of virtually every phase of agriculture and the many enterprises that may constitute a farm business. It also requires an understanding of farm people and their problems. All of this is essential in determining the amount of risk there is in any loan that would be undertaken, and in following through with the borrower after the loan is made. Most of the private banks are not equipped for this kind of business, so they try to deal with the obvious. And in the process they miss out on many opportunities for lending that may be just as safe. It is encouraging to note, however, that this weakness is beginning to be realized by some of the private banks. At least one of these banks has recently established in its central office an agricultural credit department headed by an individual who is trained both in agriculture and in finance. Other banks would do well to follow this example since it would enable them to render better service to their clients and to themselves in processing applications for agricultural loans.

The recently organized bankers' agricultural committee could provide a valuable medium for improving the service of bankers to the island's agriculture. It is in a position to do much to stimulate closer working relationships between governmental agricultural agencies and the banks which would result in a better understanding of the needs of the rural economy. The banks lack adequate information relating to the agriculture of the island, and they should be kept informed of various developments in this field. The governmental agricultural agencies could help by seeing that this committee gets the statistical and program information that becomes available in the course of their regular operations so that this material may be sure to reach the bank representatives who are directly concerned with the problems of credit for agriculture. In this way the different bankers would have an opportunity to understand the many aspects of agriculture with which they are not now familiar.

Among the established lending institutions on the island, the Puerto Rico Production Credit Association is one of the more important credit agencies for financing farm production. It was

organized by farmers with help from the Federal Government to provide a cooperative source of short-term credit that could make loans on a sound basis for all types of farm production purposes. Through the years this association has been of real help to the farmers served. In addition, it has contributed much to the opening up of credit sources for agriculture as reflected in the growing interest among the private banks in this kind of business. The Production Credit Association has been very successful, and today this financing institution is wholly owned by the farmers who are its members.

In all of its lending operations the Production Credit Association has made loans primarily for the production of sugarcane. The record of recent years shows that at least about 90 percent of the credit extended has consistently been for this crop. Although the purpose is to provide a source of credit for all types of farm production where the risk is reasonable, very few farmers other than sugarcane growers have been able to obtain a loan from this particular association. In this respect, the Puerto Rico Production Credit Association has followed a too conservative lending policy. This is clearly evident from the association's record of loans made through the years since it was organized.

Unquestionably, the Puerto Rico Production Credit Association could play a still more significant role as a credit institution serving farmers. But first this association would have to recognize what are its full responsibilities to agriculture on the island and gear its operations to the needs of all farmers who have a reasonable basis for sound credit. This could be done without jeopardizing its capital structure. With a more realistic and aggressive lending policy, this organization could very easily double the amount of business now being done and, at the same time, safely extend credit to many farmers who do not get financing at a reasonable cost. This, of course, would involve some increase in personnel to handle the greater volume of loan business, and provisions for the servicing and education of borrowers and prospective borrowers.

If after a reexamination of its lending policy and operations the Production Credit Association finds that it cannot broaden the scope of its credit service to the island's agriculture, then some other course will have to be taken. In that event, seri-

ous consideration should be given to organizing under the Federal law a second production credit association to take care of the credit needs of the eligible farmers who are unable to obtain loan service from the existing organization for purposes other than the growing of sugarcane. The amount of sound agricultural credit business that is already and potentially available on the island warrants better service and more constructive competition in this lending field.

One of the more recent developments in the field of agricultural credit in Puerto Rico is the possibility of organizing rather simple credit cooperatives to meet special needs of small producers. One such cooperative started operating in 1949-50 when it made loans totaling \$74,600, and this volume was almost tripled by the third year of operation. This is the credit cooperative organized by the members of the Cooperativa Azucarera Los Caños at Arecibo. The purpose was to provide loans to small grower-members inasmuch as this cooperatively owned sugar *central* did not provide financing for its producers, and these small farmers could not satisfy their credit requirements from existing agencies. The cooperative sugar mill supplied much of the original capital needed to get the credit association started, and most of the loan paper is rediscounted with the Federal Intermediate Credit Bank.

In addition to making loans, an important service being provided to the farmer-members of the Cooperativa Azucarera Los Caños credit association is in the cooperative buying of fertilizer. The fertilizer requirements of the growers are pooled and the credit cooperative purchases the total amount needed, thus obtaining quantity discounts that are passed on to the farmers. The growers pay for the fertilizer out of the loan that has been extended to them by the credit cooperative.

This type of lending association can be of great help in meeting credit needs, especially those of small farmers. Such credit cooperatives can provide the best substitute for the lending activities of sugar mills, large *colonos*, and merchants as well as fill the existing gap in credit for those who would be served. One of the essentials of credit to small farmers is the supervision of the use of that credit. Where a credit cooperative is organized among producers for a sugar *central*, the necessary credit supervision can be provided

by means of an agreement with the sugar mill and thus keep the cost down while protecting the security of the loan. Office space could also be made available by the sugar mill along with some other facilities which would be helpful at the start. As these credit cooperatives develop, they would be able to take care of all necessary expenses out of their own income. This is how the Cooperativa Azucarera Los Caños credit association is proceeding. The success being attained by it should stimulate the organization of similar groups in various segments of the island's agriculture. Such credit cooperatives that are formed to meet the sound financing needs especially of small farmers should be encouraged.

It takes capital to start a credit cooperative, and the lack of money among small farmers is a great obstacle in any organization effort that requires their financial participation. Fortunately, the local Government has the recently established Puerto Rico Bank for Cooperatives, and this agency could provide the necessary help to such associations. However, this bank now has certain limitations which greatly restrict its effectiveness. The bank is capitalized at only 1 million dollars. The local law which authorizes the bank's operation provides that not more than 10 percent of its capital and surplus may be lent to any one cooperative. With these limits prevailing, it obviously is not possible for the bank to lend very much money to any one group. Certainly a credit cooperative could not obtain enough financing from this source to function as it properly would have to.

Since adequate credit for agriculture is a basic problem on the island, and in view of the desirability of encouraging credit cooperatives that will fill the great need for sound financing at reasonable cost among small farmers, it is essential that the right kind of assistance be available in the necessary amounts. On the financial side, it is important for a credit cooperative to have the capital required to operate successfully. If such organizations are to be encouraged, then the Puerto Rico Bank for Cooperatives should be in position to do so. This will require an amendment to the existing law so that adequate financing may be provided. The capital available to the Puerto Rico Bank for Cooperatives should be increased to at least 5 million dollars. Also, the 10-percent limitation that is in effect should not apply in the

case of loans made to any credit cooperative. Instead, there should be a provision that will require a credit cooperative seeking a loan for its capital to match part of the total needed with some of its own money. It may be desirable to vary the amount with the size of the loan sought, but certainly a credit cooperative seeking a large loan should have the equivalent of around 25 percent of the total to be borrowed in order to insure a fundamental interest in the security of the credit it will be extending to farmers. In addition, provision should be made for adequate supervision by the Puerto Rico Bank for Cooperatives of the lending operations of credit cooperatives financially obligated to it.

Improved credit is also needed to encourage family-type farm ownership. Experience has shown that such farms can contribute greatly to more effective use of land resources and increased production through needed diversification of crop and livestock enterprises. There are many thousands of acres of land in larger farms that are being operated on a very extensive basis with the result that their total output is much below the productive capacities of these holdings. A great deal of this land is in the interior, in the coffee growing area, and much of it is in farms that are heavily mortgaged. The present owners of such farms with excess land could sell part of their acreage, pay off debts, and devote their efforts to more intensive cultivation of the land they would retain. Excess land also exists on large farms in the sugarcane areas where many thousands of acres have been freed from their former uses by the impact of mechanization and the substitution of machinery for working animals. All of the land that would be available from the larger farms in the different sections of the island could be acquired by a governmental agency such as the Land Authority, subdivided into family-type farms, and resold to rural families interested in farming if adequate financing for farm ownership could be obtained.

The Farmers Home Administration is the main source of financing for family-type farm ownership. Some of the best family-type farms on the island have been developed through the help of this agency. The record that has been achieved is outstanding in many respects, and borrowers have made good with the investment placed with them. Although farm-ownership

loans made by the Farmers Home Administration may run for a period of 40 years, a large number in Puerto Rico are paid out within a dozen years. Most of the borrowers are ahead of schedule on repayments, and all have gained not only a better foothold on the land, but have become better farmers.

One example of accomplishment in encouraging farm ownership involves 31 borrowers, former sharecroppers, who bought family-type farms on a subdivided tract in the Camuy area in 1944. Eight of these families paid off their loans in full in 6 years or less instead of the permissible 40. All of the families still owing on their loans are ahead of schedule in their repayments. Like other farm ownership borrowers of the Farmers Home Administration, they are using the variable-payment plan which enables them to pay more in good years than in bad, thus protecting them against falling behind or becoming delinquent in case of crop failure.

There is a far greater demand for family-type farm ownership loans in Puerto Rico than the Farmers Home Administration is at present in position to make out of the funds at its disposal. Yet all of the money that is allotted for such loans on the island is not being employed there. The reason for this is that under present procedures, preference is given to veterans. And although Puerto Rico has many veterans, very few of them have been interested in going into farming. As a result, all of the money not lent for farm purchase loans to veterans, is transferred to other parts of the United States where there are veterans who may want such loans. Thus in 1949-50, for example, out of almost \$526,000 available for farm ownership loans in Puerto Rico, less than 10 percent was taken up by loans to veterans and the rest was transferred. This procedure makes it impossible for all of the many qualified nonveterans on the island who want to buy family-type farms to obtain the necessary loan from the Farmers Home Administration.

If the private banks and other financial institutions of Puerto Rico would participate in the Farmers Home Administration's insured farm-mortgage program, a considerable part of the need could be filled. Every effort should be made to put this program into operation. In the meantime, however, some action is required to make farm ownership possible for the many nonveterans who



A small coffee plantation near Jayuya financed with a farm ownership loan. An additional aid in obtaining credit and providing protection against being wiped out by hurricane is coffee crop insurance made available by the Government of Puerto Rico.

are anxious to go into farming and would make good farmers. Puerto Rico desperately needs to diversify its agricultural production and thus make more effective use of its limited land resources. The family-type farm successfully operates in that way, and should be given every encouragement.

Since so few veterans in Puerto Rico are interested in going into farming, the opportunity for farm ownership should not be denied to others in this particular area where great need exists. A more tolerant interpretation of the veterans' preference provision of the law under which the Farmers Home Administration makes farm ownership loans might raise some administrative problems, but these would not be insurmountable. Within the limits set by the law, some concession to Puerto Rico should be possible to permit allot-

ted funds for farm ownership loans to be used in full on the island so as to help both veterans and nonveterans there become family-type farm owners. Such an action on the part of the Farmers Home Administration would be very helpful to the people and the economy of Puerto Rico, and be in the public interest.

An important adjunct to agricultural credit is crop insurance. The program under the Federal Crop Insurance Act has not been made available to Puerto Rico. However, the Puerto Rican Government has provided for its own crop-insurance program under legislation first enacted in 1945. This affords insurance only for coffee, providing coverage for the coffee crop and for the coffee plantations against the losses that may result from hurricanes. The crop-insurance program for coffee has done much to instill greater confidence in this in-

dustry. In the past, when no such protection was available, hurricane losses were ruinous for growers. Many of them were wiped out when a severe hurricane hit and destroyed both the coffee crop and the plantation of coffee and shade trees. Most growers did not have the money or the credit needed to rehabilitate their coffee-growing enterprises after a storm disaster. Now, with coffee-crop insurance available from the local Government, the growers who carry this insurance are more secure. And those with this form of insurance are in a good position to obtain production credit from banks and other sources since the financial risk is lessened by the coverage.

The coffee-crop insurance program started in Puerto Rico in 1946-47, when 1,421 policies were written for an amount totaling \$2,478,263. In 1951-52 there were 2,443 policies in force amounting to \$5,481,551, and coffee growers paid \$307,093 in premiums for this protection. The program is entirely self-supporting, with premiums paid by growers covering operating costs and adding to the reserves against losses. All of the insurance risk taken under this program by the Puerto Rican Government is reinsured on a participating basis. This reinsurance has been obtained from private insurance companies. In 1951-52 reinsurance covered 42 percent of the \$4,289,499 in insurance written on the coffee crop and 34.5 percent of the \$1,192,101 insurance written on coffee plantations.

While so far the Puerto Rican Government has been successful in getting private companies to reinsure the risks taken under the crop-insurance program, a great deal of difficulty has been encountered in obtaining the necessary coverage. The insurance companies, most of them in the States and a few overseas, are reluctant to take on this business for many reasons aside from the fact that there is risk involved. For the most part, the companies know very little about crop insurance. Also, the amount of income that they may derive from reinsuring the crop-insurance program for the local Government is small for any one company since no single company will take all of the reinsurance and, therefore, the risk has to be distributed among several companies. Actually, most of the private companies would rather not be bothered with this, but they have been willing to help out largely as a matter of service and accommodation since they do other business in Puerto Rico.

Reinsurance is absolutely necessary for the crop-insurance program administered by the Puerto Rican Government, which is in no position to provide this kind of protection itself. How long the private insurance companies will continue to write the necessary reinsurance for this program is problematical, even if no storm losses are experienced. It is almost certain that they will discontinue to provide reinsurance the first year after a hurricane should hit, and from then on it will undoubtedly be hard to get them to participate again.

The difficulties now being encountered, and the reluctance of the private companies to write the necessary reinsurance for the Puerto Rico crop-insurance program, must be faced squarely so that this important program may not be imperiled. The only source outside of the private insurance companies that could provide the reinsurance protection that is needed is the Federal Government under the Federal Crop Insurance Act. This law should be amended by the Congress to authorize the Federal Crop Insurance Corporation to reinsure any crop or plantation for which insurance is written under the crop-insurance program operating in Puerto Rico under local legislation. Such reinsurance would be simple and economical to handle since the Federal Crop Insurance Corporation would not deal directly with farmers but with the agency of the Puerto Rican Government responsible for administering the program among farmers on the island. This is how it now works out with the private companies writing the reinsurance, and the same satisfactory relationship could be maintained with the Federal Crop Insurance Corporation if it were authorized to provide this reinsurance protection.

The crop-insurance program in Puerto Rico is playing an important role in the agriculture of the island. Although it is now available only to coffee growers, the program is demonstrating the value of insurance protection to crop producers. Crop insurance has brought to the coffee industry confidence and a certain stability that has made it possible for growers to look ahead with their production plans and enable public and private lending agencies to increase their loans to coffee farmers. The insurance that growers take out on their coffee crop provides added security for the credit they may obtain.

Most of the lenders who finance coffee growers insist that the crop be covered by insurance for

the protection of both the grower and the lender. When loans are made, the insurance is endorsed to the lender as security and this provides a basis for sound credit which most growers never before had available to them because of the element of risk. As this program has progressed, more sources of credit have been willing to help coffee growers finance their production and improve their plantations. This has been very noticeable in recent years. During 1949-50, for example, endorsements of coffee-crop insurance on loans made to growers by private banks, governmental lending agencies, and private individuals totaled 485 and the money involved amounted to \$771,615. In 1951-52, there were 1,207 endorsements on insurance totaling \$2,448,425. This amount represented the biggest part of the total credit received by the coffee growers.

On the basis of the experience with coffee-crop insurance in Puerto Rico and similar experience with insurance for other crops in the States, it is clear that this form of protection is essential to farmers and can contribute substantially to agricultural development. Crop insurance should be extended to additional crops in Puerto Rico, and the possibilities need to be thoroughly explored.

Tobacco is one of the crops for which insurance protection would be highly desirable. It would be very helpful to the growers who, in most instances, are unable to obtain the production credit they need because of the risks in growing the crop. There is ample experience with crop insurance in the tobacco-producing areas of the United States which could be utilized to good advantage in developing such a program for Puerto Rico. Tobacco-crop insurance on the island would undoubtedly bring a great deal of stability to this important industry on which so many small farmers depend.

Also, crop insurance should be feasible for commercial plantations of bananas and plantains, and need only provide protection against disastrous losses from hurricanes. If such insurance were available for these crops, it would unquestionably stimulate production of bananas and plantains, since they have commercial export possibilities. Because these crops are susceptible to hurricane damage, it is difficult to obtain financing for their production at the present time. Insurance against such losses would greatly lessen the financial risk now involved.

Crop insurance for pineapples, sugarcane, and for cotton that is properly grown would also be very desirable. Pineapple is a crop that should be covered since its production involves a high investment per acre. Crop insurance for pineapples would be an important stimulus to bringing about needed expansion in the production of this valuable farm product in Puerto Rico.

Insurance that is written for any crop should only be for the purpose of protecting the investment that the grower has made in it so that in event of loss or disaster the farmer is not put out of business but has his money to start over again with the next crop. In order to pave the way for the needed broadening of the crop-insurance program in Puerto Rico, the local law should be amended to authorize the study and development of crop-insurance programs for other crops in addition to coffee. This authorization should extend to tobacco, bananas and plantains, pineapples, cotton, and sugarcane. Studies should be made of the feasibility of insurance for these various crops and the premium rates that would have to apply in order to make the program self-supporting. Where the studies definitely show the practicability of insurance on a sound basis for a particular crop, then provision should be made to make it available to those producers.

Credit Education and Supervision

Large numbers of farmers in Puerto Rico know very little about the ramifications of farm financing and credit. Most of the farmers seem to rely entirely on the integrity of the lenders, and in many cases they are even ignorant of the amount of their indebtedness. Farmers are confused by the wide range of methods used by lenders as to interest and fees charged, deductions made, collateral requested, and time of liquidation of a loan. This often creates friction between lenders and borrowers. Many farmers do not understand how to use credit properly, what advantages and pitfalls may be encountered in the use of credit.

At the same time, there are many lenders in Puerto Rico who do not understand the farm side of the credit problem. Loans are often made to farmers on the same terms and conditions as are urban business loans, and when the farmer cannot pay because of some natural cause which results in crop failure, the lender may find himself with an unwanted farm on his hands. Few lend-

ers are aware of what constitutes a sound farm operation outside of sugarcane growing. Many of them are unfamiliar with the basic requirements of good land use and the opportunities for increasing farm production through pasture improvement, adoption of improved farming practices and cropping systems, and diversification by the expansion or addition of crop and livestock enterprises.

Thus among both groups—farmers and lenders—there is need for more information and education on the practical aspects of agricultural financing. One of the first steps toward improving the agricultural credit structure in Puerto Rico is to meet this need. The lack of information and education relating to credit for farmers has been one of the handicaps in the development of a better agricultural credit system on the island. Agencies involved in agricultural education have confined their efforts mainly to the problems of production without giving other problems, such as credit, the necessary emphasis. Lack of information even hinders the full use of existing facilities. Most of the credit agencies in the best position to serve farmers lack aggressiveness; they do not seek business. These agencies wait for farmers to seek their services. This is another reason why an active informational and educational program is necessary in the field of agricultural finance.

All of the governmental agricultural agencies working with farmers and the established credit institutions, both public and private, could work together in developing and carrying out a credit education program. The Agricultural Extension Service is in a favorable position to assume leadership in such an activity and work in cooperation with other agencies such as the Puerto Rican Department of Agriculture, the Experiment Station, and governmental credit organizations and private banks as well as with vocational agricultural workers and farm organizations. A highly capable specialist on agricultural credit problems should be in charge of this work for the Extension Service.

The amount of information now available on developments relating to agricultural credit and farm financing is inadequate. Such information, including facts about farm and land values, should be brought together by the Puerto Rican Department of Agriculture so that the situation

and trends in agricultural credit on the island may be more readily known. Also, more information and knowledge about agricultural credit and finance must be developed through research, and the responsibility for this should rest with the Experiment Station. Schools teaching vocational agriculture could render valuable assistance by providing courses in agricultural credit and finance for young and adult farmers. More emphasis on the practical phases of this subject should also be given at the College of Agriculture and Mechanic Arts for the benefit of students who later may go into agricultural work. The various lending agencies of the Federal Government could improve their services by making available information that would help farmers know more about these sources of credit. The Production Credit Association could do a great deal in this field of information and education that would benefit its members and make more farmers aware of the services available from this agency. By utilizing the bankers agricultural committee as a coordinating body, and with the help of this group, the private banks could provide effective cooperation in an educational and informational program on agricultural credit.

When a loan is extended, the supervision of this credit becomes of utmost importance. Many of the existing sources of credit provide supervision in one way or another, the most effective being supplied by the Farmers Home Administration. Sugar mills usually have field employees who make periodic visits to their borrowers to make sure that the credit extended is being properly employed by the growers. These same employees help the farmers determine their needs for financing on the basis of the estimated sugarcane production on each of the farms, thus making possible adjustments in the amounts of the loans. The sugar mills make the loan money available on a weekly basis as the needs of the farmers arise. The same method is followed by dealers and some others who make loans to tobacco growers. The Production Credit Association has a system of credit supervision under which fieldmen periodically inspect and supervise the use of funds borrowed from the association for production purposes. The private banks in some instances have field supervisors and in other cases, where they have local branches, they depend on the judgment and supervision of their local managers.

Proper supervision of agricultural credit is essential, not only for the protection of the lender, but also from the standpoint of the borrower, to make sure that the money lent is being used to the best advantage for the purpose it was obtained. With a program of credit supervision, lending agencies are in position to minimize their risk on loans while at the same time improving their services to farmer borrowers.

Where the volume of credit business is small, it is almost impossible for a lending agency to provide the necessary supervision. This would be especially true of such groups as credit cooperatives that may be organized to meet the needs of small farmers. If these organizations are financed by the Puerto Rico Bank for Cooperatives, provision should be made by the bank for the needed supervision. It is not enough to provide funds; supervision is necessary so as to make sure that farmers who borrow from these credit cooperatives get proper help and guidance on the use of those funds and thus afford greater assurance for repayment. In the case of credit cooperatives organized around sugar mills or around existing cooperatives handling farm products, credit supervision can be tied in with the structure of those agencies. Otherwise, provision for credit supervision will have to be made, and where the credit cooperative is organized with the help of the Puerto Rico Bank for Cooperatives, the bank will have to provide it as a matter of sound business.

Legal Obstacles in Agricultural Credit

In some respects, the Puerto Rican laws and procedures affecting agricultural credit need to be improved. They present certain obstacles that hinder the expediting of loans to farmers.

The mortgage law of Puerto Rico is taken from and patterned after the mortgage law of Spain. Moreover, it has developed almost wholly from the mortgage law of Spain as interpreted by the courts of Spain, with the exception of certain influences of the common law which have made their imprint since Puerto Rico came under United States sovereignty. The mortgage law, insofar as the law itself is concerned, could be improved only with difficulty. It apparently is adequate for agricultural purposes and in many respects superior to the land laws of various States of the mainland.

Administratively, the registration and protection of land titles are in registries of property created under Puerto Rican law with jurisdiction according to districts. There are 12 registry districts, geographical in nature. Within each district, some farms are not registered, and some farms are registered. Those which are registered are identified in appropriate registry books by contiguous owner descriptions supported, in some instances, by survey plats, each farm being identified by a number. The particular number assigned to a particular farm never disappears from the registry books. When a farm is segregated, the segregated parcels are given new numbers. Likewise, when more than one farm is consolidated into a single farm, the new farm is given a new registry number. By referring to farm numbers, the registrar of property can trace the history of a farm backward to the time of its original registration. Appropriate spaces are allowed in the volume and page where the farm is registered for a recordation of liens, encumbrances, and transfers.

Under existing laws, regulations, and custom, each registry of property office is under the jurisdiction of a registrar of property who generally has one chief clerk and one or more assistant clerks. The registrar of property must be a qualified attorney at law, must pass an examination, and receive his appointment from and under the general jurisdiction of the Office of the Attorney General of Puerto Rico.

Salaries for registrars ranged in 1950 from \$4,500 to \$5,000 per annum, depending upon the volume of work in the registry. Registrars are not entitled to annual leave with pay. In case of absence from the office, the registrar must appoint a member of the bar to act for him, and if he is absent for more than 30 days, the acting registrar receives half of his salary. Salaries for registrars in registry offices are provided by annual appropriations of the Legislature.

Fees for recording documents in the registry of property are charged as provided by law, and all income received through fees is credited to the general fund in the Treasury of Puerto Rico. None of the income collected in the registries remains for the support of the registries.

While there is no serious fault with the basic mortgage law of Puerto Rico, improvements could be made in the operation of the registry

offices if certain provisions of the mortgage law and certain regulations were modified.

At the present time, registrars are appointed by the Attorney General of Puerto Rico. It would, perhaps, be more desirable if the registrars were appointed by the Supreme Court of Puerto Rico only after this court has found them to be duly qualified attorneys with special knowledge and experience of the mortgage law of Puerto Rico, and that a system of advancement and promotion from lesser registry offices to more prominent registry offices in the island be automatically provided as vacancies occur in the more prominent offices.

Registrars of property are required under the law to act in a quasi-judicial capacity to determine if public documents are recordable under the law. Their decisions may be reviewed only by the Puerto Rican Supreme Court. They are required by law also to issue, upon request and the payment of the authorized fee, title certificates to properly interested parties. The title certificates must show the title history and all recorded liens, encumbrances and transfers, and curable and incurable defects of title. In essence, the title certificates issued by registrars of property are in lieu of abstracts of title prepared in some States by qualified title abstractors and of title certificates issued in other States by title insurance companies. Although there is no suggestion that incompetent registrars are appointed by the Attorney General, the opportunity exists for the appointment of politically incompetent registrars, which always is a danger to the proper operation of the registry offices.

Salaries should be increased for registrars of property and proper provisions made for leave with pay and for retirement. At the present time, with salaries so low, registrars all too often are confronted with the temptation of accepting extralegal compensation from special interests for giving preference to the registration of specified documents, causing unwarranted delay in the registration of documents for which no bonus is or can be paid.

Provision should be made for a chief inspector of registries with an appropriate and competent staff to lend assistance to the various registrars of property in case of need, and to inspect the books in the registries to determine that the duties in the registries are being capably and properly fulfilled. A member of the office of the inspector

of registries should be qualified to take over the duties of a registrar of property when the registrar is absent or on leave. At the present time, when a registrar is absent, he must appoint an attorney located in the town where the registry of property is located to act as registrar without pay, or if that is not possible, the nearest district attorney. Experience has shown that this method is entirely unworkable and unsatisfactory, for neither the attorney nor the district attorney has proper time to give to the registry office, and the work in the office is unreasonably delayed.

The personnel in the registry offices now consist of a chief clerk and of one or more additional clerks. Most of the registry offices are woefully understaffed, and many of the clerks are inexperienced and underpaid. No competent secretarial assistance is provided for the registrars of property, some of whom must do their own typing and prepare their own title certificates to fulfill requests from farm owners, mortgagees, and creditors. Each registry office should be staffed with a chief clerk, and an adequate number of trained registry clerks, and one or more stenographer-typists.

In many of the registry offices the more ancient records are falling apart from lack of funds properly to maintain them. Adequate funds should be provided for the proper rebinding, replacement, or other adequate provision for the restoration of old records to which constant reference must be made in the registry office. If these old records are allowed to fall apart and become lost, it will be impossible for a farm owner or other interested party adequately to obtain a title history of his farm when needed.

The registry of property offices are one of the few systems of government offices which obtains sufficient revenue for self support. All of the funds, however, are transferred to the general fund in the Treasury and are lost to the registry offices. In return, inadequate annual appropriations are made to maintain office records and salary scales which provide little incentive for qualified personnel. All fees received in the registries of property should be set aside in a special revolving fund for the maintenance and operation of registry offices. Experience has shown that if this were done, sufficient income would be available to pay the suggested increased salaries, to rebind, restore, and properly maintain the records

in the office, and generally to inspire greater, faster, and more efficient service from the registries. If these improvements could be made in the registry offices, the unreasonable and disappointing delays which now occur in the issuance of registry certificates and in the inscription of documents in the registries would be obviated. It is believed that these factors are the ones which require the immediate attention of the Puerto Rican Government, for the removal of such impediments in the registries would greatly facilitate the ability of and desire for lending agencies to increase their agricultural credit.

Crop loans generally are now made under the security afforded by the crop lien law of Puerto Rico, or under an archaic system of feudal advances whereby the farmer is required to mortgage his crop with the person, firm, or organization advancing the credit to plant, harvest, and cultivate it.

The crop lien law of Puerto Rico, first passed in 1910, has been amended at various times. Even with the amendments, the crop lien law is obscure, ambiguous, and does not provide adequate remedies for the enforcement of the crop lien by the creditor.

Although the Legislature has made some attempt, under the law, to divorce crop credit from real estate credit, there has been a general resistance on the part of the lawmakers to completely divorce the crop lien law from the mortgage law of Puerto Rico. As a result, while for

other personal property the husband of the conjugal partnership is the general administrator for the wife, and can make transfers for her, under the crop lien law, both the husband and wife must execute the document as in the case of a transfer of real property. Furthermore, the registration fees for the recording of crop lien contracts are so expensive that creditors in position to advance crop credit (other than Government lending agencies) either refuse to do so, or resort to an inadequate system of assignments, or divide their farmer debtors under the system of feudal advances in order that they may maintain strict control over the proceeds from the crops, giving rise to an involuntary credit system on the part of the debtor.

The personal property mortgage law of Puerto Rico is, for all practical purposes, a good law. As has been done in most of the States, either the personal property mortgage law and the crop lien law should be consolidated into one chattel mortgage law wherein the husband alone would have the right to mortgage the crops as personal property, or a new and separate crop lien law should be provided by the Legislature which gives unto crops the sole characteristic of personal property, and completely divorces the legal aspects of crops from the mortgage, and provides adequate safeguards for the protection of the creditors and adequate remedies for the collection of the loan from the crops. This would provide a cheap and easy method of recording crop liens.

Chapter X

Potentials in Agricultural Production

By substituting improved techniques of production for outmoded traditional methods, and with some shift in land use, Puerto Rico could have a well diversified and highly productive agricultural industry. The resulting increases in production would enable the island to become much less dependent on food imports and at the same time permit maximum shipments of all those farm products that could be absorbed by outside markets with reasonable returns to Puerto Rican producers. Such a development would greatly strengthen the economy and bring about a substantial increase in the income from agricultural production.

Since only a relatively small area is available for farming purposes, the main hope for raising the level of agricultural output lies in obtaining higher yields from each acre. This requires widespread utilization of management and cultural practices that are recognized as being essential for growing good crops. It means general use of improved varieties, greater and more effective use of fertilizers, application of sprays and dusts to control insects and diseases, employment of improved marketing practices and facilities, and use of various other measures that effectively contribute to sustained high-level production.

Only a comparatively few farmers in Puerto Rico now follow many of the production practices that are necessary for attaining high yields. Most of these are sugarcane producers. Only a few are to be found in other agricultural enterprises. The farmers who plant a crop but do little in addition to make it grow are in the majority. These farmers are planters, not growers. About all they do is put the seed in the ground and leave the rest to the whims of Mother Nature. They use little or no fertilizer, and rarely protect the growing plants

from insect damage or diseases by spraying or dusting. When the harvest is ready, these farmers must accept whatever yield there is. Small at best is the reward of being a planter and not a grower.

What Puerto Rico needs is for more and more of its farmers to be growers—good growers—who will employ the improved methods and practices of crop production that result in greater and more profitable yields. There exists on the island a vast store of information on agricultural production techniques developed through experimentation and research by local agencies. New improved varieties of crops have been brought into being through breeding. With all of this readily available to farmers, the fact remains that most of them continue to follow their own traditional production methods. Thus, if production from the limited land resources in Puerto Rico is to be increased, the wide gap that now exists between science and actual practice will have to be bridged. More positive efforts will have to be made to encourage farmers to adopt improved production methods and utilize improved varieties which result in higher and more profitable yields.

For the most part, the farmers who grow sugarcane, which is by far the major crop in Puerto Rico, stand head and shoulders above all the other farmers in their use of advanced production practices. But even among these growers there is a big job to be done to bring about further improvements in the methods employed so as to attain higher yields in order to make more effective use of land resources and at the same time raise total farm income. With greater yields per acre, less land would be required for producing the total tonnage of sugar that the cane growers are able to market. The released land could be utilized

for other agricultural purposes that would add to the total of production and income. With proper use of additional fertilizer, especially nitrogen, and widespread use of higher yielding varieties of cane which are already developed and tested, the land employed in producing sugarcane in 1951 could have been reduced by approximately 25 percent. And on this smaller cane acreage the possibilities for further increasing per acre yields on an economical basis would still remain ample.

In practically all other agricultural enterprises on the island, the main need also is for greater yields from the land resources already being employed. In the case of tobacco, somewhat less land would need to be devoted to that crop if per acre yields were improved. For the food crops, however, there is urgent need for greater productivity, more diversification, and some increases in acreage. The general level of agricultural production outside of sugarcane and pineapples could be increased by at least 50 percent simply by the use of proper amounts of fertilizer at the right time. This is a very moderate estimate since many of the crops are being produced without fertilizer or proper care. Large numbers of farmers could readily double or even triple their present yields and returns by employing the right combination of growing practices which would include proper land preparation, use of improved varieties, application of adequate amounts of the necessary fertilizers, control of damage from insects and diseases, and proper tillage of the soil to regulate moisture and keep down weeds.

The possibilities of increasing the production from livestock are also great. Most of the cattle kept on farms are nondescript, and the output per animal unit averages very low. With more attention to breeding and selection and with improved management it is obvious that the production per cow could be increased substantially from the present average of only about 2,000 pounds of milk per year. And if livestock production is to be increased on an economical basis, there will need to be a marked expansion in the supply of feed grown locally. Puerto Rico has a rather considerable portion of land that could be utilized most advantageously for pasture. But the biggest part of this acreage now has poor carrying capacity. An extensive pasture improvement program would return rich dividends by sharply raising the carrying capacity of pasture lands and making

them the major source of feed for livestock. This would enable farmers to keep a larger number of higher yielding cows and permit milk and meat to be produced more economically with less reliance on imported feeds.

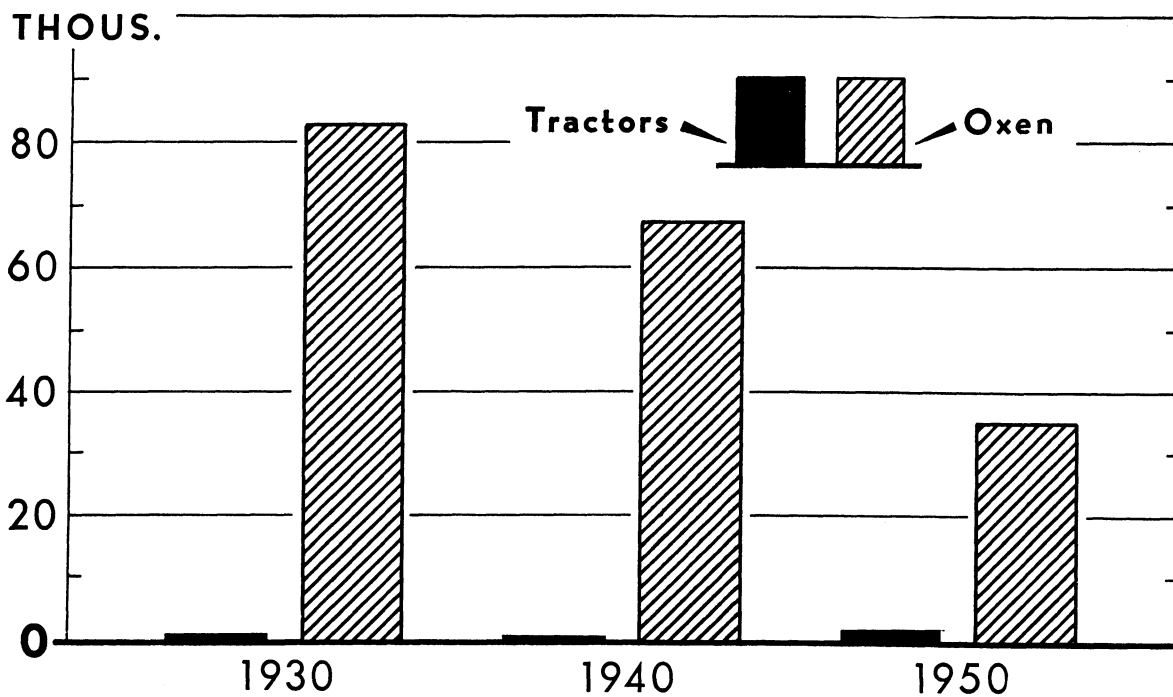
Technology in Farming

The hoe and the machete have long been characteristic of agriculture in Puerto Rico. These two hand tools stand out as symbols in a system of farming that still is primitive in many respects. Technology in agriculture has lagged behind the advances made in other fields of activity. Mechanization has been slow in all farming enterprises except in the production of sugarcane. And even in this industry the use of mechanical equipment could be increased considerably.

Most of the mechanical equipment is to be found in the coastal regions where the land is flat to gently rolling and is adapted to the use of machinery. The bulk of such land grows sugarcane. In the upland areas, where topography is a limiting factor in mechanizing crop production, few farmers utilize mechanical equipment in their farm operations. Of the 53,515 farms shown by the 1950 census, 423 farms reported 619 wheel tractors and 604 farms reported 1,007 crawler tractors. By far the greatest numbers were in the areas growing sugarcane. By way of contrast, the figures also showed 7,268 farms with 35,420 work oxen. This, however, compares favorably with 8,356 farms reporting 67,552 work oxen in 1940.

The present trend in the mechanization of sugarcane production really began early in the current century soon after Puerto Rico came under the American flag. This set in as a sudden development on an island that was unprepared for such a transition. As the importance of sugar increased and land holdings become consolidated for cane production, more mechanical equipment came into use to grow and transport this crop. Other agricultural enterprises, however, long remained virtually untouched by this new shift to the use of mechanical power and machinery. The mechanization of sugarcane production in Puerto Rico did not continue as rapidly as might have been expected largely because of the abundance of cheap labor in the world's sugar producing areas. At the time that this crop began to attain primary importance in Puerto Rico, its culture was limited to tropical areas, not developed industrial-

TRACTORS AND WORK OXEN On Farms in Puerto Rico, Selected Periods



DATA FROM THE BUREAU OF THE CENSUS

Tractors have been taking the place of work oxen in the agriculture of Puerto Rico. Between 1930 and 1950 the number of tractors almost doubled to a total exceeding 1,600 while the number of work oxen declined from 83,000 to about 35,400.

ly, and therefore having a good supply of cheap labor. Also the sugar industry of Louisiana and Florida (areas of relatively high labor costs compared with tropical regions) had not yet been developed. At the time there was not felt a great need to develop machinery for the cultivation and harvesting of sugarcane, the operations requiring the most labor. Consequently, up to the present, most of the agricultural mechanization in Puerto Rico, because of the history of its main farm enterprise, has been limited largely to soil preparation and to transportation.

In more recent years, however, several factors have been at work to force a greater use of modern methods and machines in Puerto Rican agriculture. The most important factor favoring technological progress is the increasing competitive pressure on the sugar industry in Puerto Rico

from other producing areas. Striking advances have been made in the mechanization of sugar-beet and sugarcane culture on the mainland. The sugar industries of Hawaii and Cuba are becoming increasingly mechanized in an effort to attain a more favorable position in the highly competitive sugar market. All of this competition presents a real threat to the sugar industry of Puerto Rico. It can be met only by increasing productivity and by reducing costs through more extensive mechanization and by achieving greater efficiency in growing and processing the crop.

Throughout most of the history of agriculture in Puerto Rico, there has been no urgent need to save labor, and this has worked against technological advancements that would increase productivity and lower unit costs. That is why the outmoded traditional methods of farming have

become so deep-rooted in the economy of the island. These primitive and obsolete methods will have to give way to more modern and efficient techniques of production if the productivity of the land is to be substantially increased and the present low standards of living of the people raised to higher levels.

The progress made so far in the mechanization of Puerto Rican agriculture has not been without some struggle. Because of the abundance of laborers on the island, the labor leaders in the agricultural field have tenaciously opposed various mechanization practices. These practices might increase the productivity of workers and thereby raise the earnings of the individuals employed. The fear is that mechanization reduces total employment. Actually, it does bring about temporary unemployment in certain instances. But, at the same time, it opens up new employment opportunities in related fields.

A man swinging a hoe or a machete requires little from the service or business side of the economy, and productivity is definitely limited to the strength and pace of the individual. A machine, however, not only requires the work of an operator, and is many times more productive, but it also has to be kept in operating condition and eventually must be replaced, thus contributing much to both the service and the business sides of the economy. In the long run the increase in production that results from proper mechanization and improved production methods means more total employment but in a somewhat different pattern and with a higher level of earnings and skills for the entire labor force. This is not now generally understood either by the workers or by the labor leaders in the agriculture of Puerto Rico. If the leaders do understand the contribution that technological improvements in agriculture can make to the economic welfare of the island, they do not show it by their insistence on perpetuating a maximum of manual employment. Already this has given rise to the practice of spreading available work among more people, since the labor force is expanding. Thus, as underemployment increases, more and more people have less and less.

In general, there are two ways by which the yearly income of laborers can be increased. One is through a greater participation in the total earnings produced by an enterprise, and the other is through increased labor efficiency for which the

worker is compensated. There obviously is a limit to the share that laborers may take out of total production, since the activity in which they are employed might become unproductive to the employer who therefore might curtail or discontinue the enterprise. On the other hand, there are the possibilities for improving real wages through increased labor productivity. And in Puerto Rico these possibilities are substantial. The fact remains, nevertheless, that unless employment is available for workers displaced on a particular job by improved technology, even though the displacement may be only temporary, it is going to be very difficult, both from the economic and social standpoints, to bring about any great degree of technological advancement in established agricultural enterprises in Puerto Rico. However, in the case of new or rapidly expanding enterprises, it is much easier to bring about improvements in production techniques since the additional activity means more jobs.

There is much that can be gained for the economy and the people of Puerto Rico through more widespread use of adapted machinery and improved methods that will increase efficiency and productivity in agriculture. This is not an untried road. Where such a course has been judiciously followed in any part of the world it has been of great benefit to the welfare of the area by increasing both production and employment opportunities. Puerto Rico should be able to profit likewise. The fear on the part of labor that now acts as a roadblock must be dispelled. To do this requires education, planning, and action. If mechanization and the adoption of improved methods are to advance in Puerto Rico without labor fearing widespread unemployment, then adequate steps need to be taken to provide for the period of transition and to aid workers in making the necessary adjustments. This calls for understanding and cooperation on the part of labor, private enterprise, and Government.

In approaching this problem it must be recognized that what external competition is doing to force technological development in the sugar industry of Puerto Rico, will be exerted by that industry through internal and indirect competition against the other agricultural enterprises on the island. The productivity per worker cannot be increased in sugarcane without forcing a somewhat equivalent increase in other enterprises. The



The cutting of sugarcane is a hand operation in Puerto Rico.

wage differential alone is an important factor to induce an increase in labor productivity through improved technology in the backward enterprises. In recent years under the Sugar Act, wage rates in sugarcane have been raised with a lifting effect on wages paid for other agricultural work. Therefore, the greater technological advances that may be anticipated in the production of sugarcane will have a profound effect in every branch of agriculture on the island.

Although the production of sugarcane is far more mechanized than any other agricultural enterprise in Puerto Rico, this industry still must bring into use many more technological developments in order to improve its competitive position in relation to other sugar-producing areas. A relatively large number of man-hours of field labor is required to produce a ton of raw sugar in Puerto Rico because of the extensive employment of hand laborers in planting, cultivating, and harvesting operations. Although yields of 96° raw sugar per acre in Puerto Rico average above

those in other United States areas, with the exception of Hawaii, a study of data for the 1950 crop shows field labor requirements of 109.8 man-hours per ton of 96° raw sugar for Puerto Rico, 86.5 man-hours for Louisiana, 46.6 man-hours for Florida, and 26.6 man-hours for Hawaii.

In all the operations of soil preparation for sugarcane production in Puerto Rico, tractors and tractor-drawn equipment are used except on the small farms and on land that is too steep for mechanical power. On these small farms and steep lands, oxen are still used for draft power. All of the sugarcane planting is done by hand. The cultivating operations are as yet only slightly mechanized. Only a few large sugar growers are experimenting with mechanical weeders. However, chemical weed killers are being used widely. This material is usually applied with individual knapsack sprayers, and only a few power sprayers are employed. The use of liquid fertilizers is being tried by one large sugar producer. So is overhead irrigation. The entire sugarcane crop is harvested

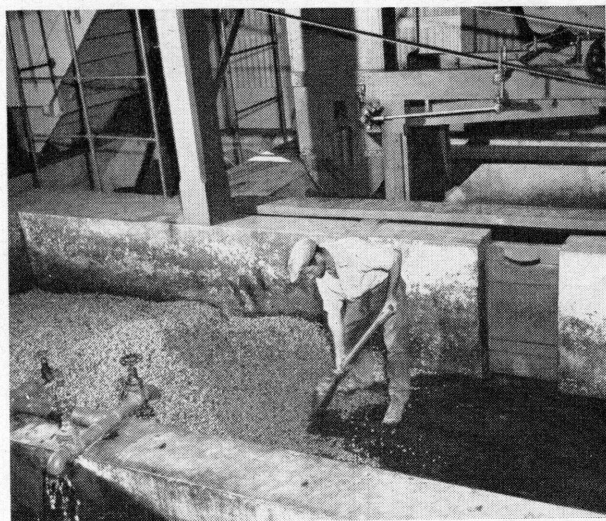
manually. Laborers cut, top, and strip all the cane by hand, using machetes. The cane is hauled from farms to *centrals* by rail, truck, tractor-pulled carts, and some oxcarts. Most of the cane is loaded by hand in the field and moved to loading stations for transfer to rail cars or trucks. Usually cane is hauled to loading stations in tractor carts, oxcarts, or small rail cars operating on portable tracks laid in the fields. In dry weather trucks may load in the fields, eliminating the transfer at a loading station. While it is apparent that considerable savings of labor are possible in almost every phase of sugar production on the island, the planting, cultivating, and harvesting operations offer the biggest opportunities for reducing costs. These operations require the greatest amount of man labor, and they have not yet been mechanized. And yet technology in the sugar industry is more highly developed than in any other agricultural enterprise on the island.

Dairying, for example, has expanded in Puerto Rico during recent years. This industry is only slightly mechanized. As a result, the man-hours needed to produce 100 pounds of milk is from three to four times as great as the number required on the mainland. Only a few dairies in Puerto Rico use milking machines. Few use power mowers or cutters. Still fewer have silos. Farm and barn layouts are poor. Production is low. There can be little doubt as to the important role that mechanization and related technology could play in the improvement of dairying on the island.

The production of coffee as carried on in Puerto Rico does not lend itself to a great deal of mechanization. This crop is produced in the mountainous areas. The terrain and the nature of the trees preclude the use of machinery in growing this crop. However, there is room for a great deal of technological improvement in the handling and processing of the coffee after harvest.

Pineapple growing has good possibilities of becoming an important agricultural enterprise in Puerto Rico. To the extent that this crop is now being produced, it ranks with sugarcane in the degree that production is mechanized. And like sugarcane, there are many technological improvements that still need to be made.

Very little mechanization is found in other agricultural enterprises on the island. In general, most of these crops are grown by small farmers, on hilly and broken land, and with little



In the initial steps of processing coffee on the plantations, the coffee berries are run through a pulping machine, put into a tank for washing, then allowed to ferment to remove all of the pulpy and gelatinous material that may cling to the beans. After additional washings the coffee beans are ready for drying either by natural means in the tropical sun or by mechanical driers which are being used to an increasing extent.

capital at their disposal. Animal power predominates in soil preparation, and this is about the only operation where some equipment is used. Planting seed by hand is usual on these small farms. Cultivating is done mostly by hand hoeing or weed pulling. Harvesting is a hand operation. If there is any shelling or threshing to be done, it is accomplished by vigorously whacking the sun-dried plants with a long pole or other similar means. Winnowing is done by hand, letting the grain fall on the floor from the pan held overhead. All of these functions have been performed the same way for many past decades. The varieties planted may be new, at times some fertilizer is used, but the operations involved in growing and harvesting have undergone little change.

In all of this picture there is one striking fact—few people engaged in Puerto Rican agriculture either as farm operators or as workers recognize the full importance of mechanization and the adoption of improved methods in the progress of their industry. To the limited extent that these advances have been accepted and applied over the years, production has been increased and employment expanded. The displacement of oxen by tractors, trucks, and other mechanical equipment since the 1920's, for example, not only enabled the sugar industry to undergo a tremendous expansion, but also paved the way for growth in

other enterprises. Much land formerly required to produce feed for the draft animals was released for more productive purposes, and this also added to the total output and provided new opportunities for employment. Although these changes have been taking place over a number of years, in the main they have passed unnoticed. And yet, the present high acreage of sugarcane could not have been produced with the methods and facilities available in those earlier years. The number of draft animals and the land that would have been required to feed them would have made it impossible to achieve the present level of agricultural production on the island. What has happened thus far is only an indication of the great benefits still to be derived by the economy from a broader application of improved technology in the island's agricultural industry.

Conditions demand that the way be paved for greater technological progress not only through education but also through research and developmental work. This is a field in which such local agencies as the Experiment Station, the Extension Service, and the School of Agriculture at Mayagüez must play more prominent and aggressive roles. More research and experimental work in agricultural engineering and farm building design are needed to develop ways and means of meeting the special problems that exist on the island. This is a task for the Experiment Station. The job of working with farmers and helping them solve their farm engineering and building problems properly belongs to the Extension Service, but this agency needs to be adequately staffed to do this necessary educational work. The School of Agriculture also needs to be adequately staffed and equipped for the teaching and training of its students. Among these three agencies there could well be a pooling of resources so that the necessary research, developmental, and educational activities in agricultural engineering and farm structure design may be carried on effectively and yet with a minimum of cost.

The Present Pattern in Agriculture

Puerto Rico has only about 1,900,000 *cuerdas* of land in farms. Of this total, slightly more than 40 percent is cropped, nearly 35 percent is in cleared pasture, and about 8 percent in wooded and other pasture. The remainder consists of

forest area, waste or swampy land, and land occupied by roads and buildings. Out of the total area in farms, the farmers of Puerto Rico realized a total production in 1950-51 valued at \$204,182,000 (table 35). This was a record for the island, and exceeded by approximately 15 million dollars the previous high set in 1948-49.

Sugarcane occupies more land than any other single crop in Puerto Rico and has long contributed the biggest part of the income from agriculture. In 1950-51, nearly 45 percent of the total land in crops was devoted to growing sugarcane, and the value of the cane produced totaled \$106,379,000, with an additional \$5,122,000 derived from molasses. The gross value of all other agricultural production amounted to \$92,681,000, of which about 55 percent came from livestock products.

Coffee is the second most important single crop in terms of the amount of land used and the value from production. This crop is spread out on nearly one-fifth of the land in crops. The value of the coffee produced—mostly for local consumption—in 1950-51 totaled \$8,402,000.

The second leading export crop is tobacco which, like sugar, is produced mainly for the continental United States market. Tobacco uses less than 4 percent of the land in crops, and in 1950-51 the value of production amounted to \$6,355,000.

Most of the other crops and all of the livestock products are produced for consumption on the island. With some exceptions, the output is inadequate in relation to the demand that exists or which could be developed. The most plentiful products grown are the starchy vegetables including bananas and plantains. Both of the latter are used primarily while still green for cooking as a starchy vegetable. Many of these and other products could be produced in greater quantities both for local sale and outside shipment.

The production of farm products in the category of starchy vegetables had a value of \$10,642,000 in 1950-51. Bananas contributed \$4,556,000 of this total, mostly from production for local use as a starchy vegetable with perhaps 10 to 15 percent allowed to ripen for consumption as a fruit. A very few bananas were shipped to the mainland, and more could have been moved if they were available. The next important item grown for local consumption was plantains, the value of production amounting to \$1,717,000.

Table 35.—Total production, farm price and value of farm output in Puerto Rico, 1950–51 ¹

	Unit	Production	Farm price	Total value
			<i>Dollars</i>	<i>1,000 dollars</i>
Value all farm output.....				204, 182
Principal crops, total.....				126, 258
Sugarcane.....	Ton.....	10, 501, 396	10. 13	106, 379
Molasses.....	Gallon.....	60, 256, 209	0. 085	5, 122
Tobacco.....	100 pounds.....	255, 000	24. 92	6, 355
Coffee.....	do.....	172, 000	48. 85	8, 402
Livestock products, total.....				50, 519
Milk.....	Quart.....	152, 165, 215	0. 1410	21, 455
Eggs.....	Dozen.....	9, 123, 768	0. 5976	5, 452
Beef.....	100 pounds.....	211, 526	36. 07	7, 630
Pork.....	do.....	187, 714	33. 42	6, 273
Poultry.....	do.....	141, 847	65. 30	9, 263
Goat and other meats.....	do.....	9, 397	47. 47	446
Legumes, total.....				2, 453
Beans, dry.....	100 pounds.....	94, 286	12. 48	1, 177
Pigeonpeas.....	do.....	107, 079	10. 76	1, 152
Cowpeas and other legumes.....	do.....	17, 672	7. 01	124
Fruits, total.....				4, 690
Grapefruit.....	1,000 fruits.....	9, 703	16. 91	164
Pineapple.....	Crate.....	791, 429	1. 63	1, 290
Oranges.....	1,000 fruits.....	185, 030	3. 41	631
Avocados.....	do.....	36, 457	17. 49	638
Citrons.....	do.....	6, 800	30. 20	205
Mangoes.....	do.....	59, 192	2. 82	167
Coconuts.....	do.....	23, 187	59. 53	1, 380
Other fruits.....				215
Starchy vegetables, total.....				10, 642
Sweetpotatoes.....	100 pounds.....	792, 685	1. 93	1, 530
Cassava.....	do.....	90, 807	1. 53	139
Taniers.....	do.....	333, 873	3. 00	1, 002
Yams.....	do.....	252, 516	2. 00	505
Dasheens.....	do.....	199, 301	1. 43	285
Plantains.....	1,000 fruits.....	117, 268	14. 64	1, 717
Bananas.....	do.....	1, 320, 654	3. 45	4, 556
Breadfruit.....	do.....	53, 842	16. 86	908
Cereals, total.....				1, 539
Corn.....	100 pounds.....	329, 347	4. 15	1, 367
Rice.....	do.....	28, 664	5. 99	172
Green and yellow vegetables, total.....				2, 873
Tomatoes.....	100 pounds.....	173, 081	5. 16	893
Peppers.....	do.....	64, 130	5. 67	364
Cabbage.....	do.....	155, 192	2. 44	379
Squash, pumpkins.....	do.....	188, 656	2. 11	398
All others.....				839
Other farm products, total.....				5, 208
Charcoal.....	Bags.....	7, 561, 512	0. 38	2, 873
Wood.....				725
Cotton (unginned).....	100 pounds.....	11, 405	13. 35	152
Ornamentals.....				1, 300
Honey.....	Gallons.....	51, 815	1. 33	69
Miscellaneous.....				89

¹ Estimated by the Department of Agriculture of Puerto Rico.

Sweetpotatoes yielded \$1,530,000, while the value of taniers totaled \$1,002,000. Breadfruit, yams, dasheens, and cassava made up the remainder of the total for the starchy vegetable category.

Among the fruits such as pineapples, oranges, grapefruit, limes, mangoes, avocados, coconuts, and others, the value of production in 1950-51 totaled \$4,690,000. Most of the fruits grown are for local consumption, but the potentialities of the internal and external markets still remain to be developed. Among these fruits, some pineapples and coconuts are shipped to outside markets but the volume is small compared to the quantities that could be sold if supplies were more adequate both for local consumption and shipment. The farm value of pineapples produced amounted to \$1,290,000, while that of coconuts totaled \$1,380,000. Oranges and avocados accounted for roughly two-thirds of a million dollars each.

Dry edible beans, pigeonpeas, cowpeas, and other legumes produced a total of \$2,453,000. Most of this amount was nearly equally divided between dry beans and pigeonpeas, both important foods used on the island. Because of the great lack of adequate production, large imports of beans

are necessary to meet the requirements of the population.

The vegetables which are regarded as being among the protective foods essential to a good diet are produced in very limited quantities in Puerto Rico. The value of production of these products in 1950-51 totaled only \$2,873,000. Occasionally, a few vegetables such as tomatoes, cucumbers, and peppers are available for shipment to the mainland. Usually, however, the supply of vegetables grown fails to meet the continuous local needs and imports are necessary, although there are some short periods when supplies of certain common items are temporarily plentiful.

The production of grains and cereals such as corn and rice is far less than the island's requirements for human and animal consumption. The value of the output in 1950-51 totaled only \$1,539,000, and many times as much had to be spent for imported supplies.

In recent years there has been a considerable increase in the production of livestock products, following increases in dairy cattle and poultry. The value of livestock products produced reached a record total of \$50,519,000 in 1950-51. The



Many oxen are still used in Puerto Rico's sugarcane harvest.

greatest contribution was made by the rising production of milk, which in 1950-51 had a value of \$21,455,000. The production of eggs added \$5,452,000 to the value of farm products produced, and another \$9,263,000 came from poultry that was raised mostly for meat. The production of beef was valued at \$7,630,000. The value of pork produced totaled \$6,273,000. Even though the production of milk and poultry products has been increasing, the output of these important foods is extremely low in relation to both the demand and requirements. This situation is made more serious by the low production of meats, which has tended to remain static or even decline while population continues to rise.

A variety of other farm products produced in 1950-51 had a value of \$5,208,000. Of this amount \$2,873,000 came from charcoal and \$725,000 from wood. The value of ornamentals produced for local and outside markets totaled \$1,300,000, and \$152,000 was the value of cotton grown.

Considering the different farming enterprises and the pattern of production that now exists in Puerto Rico, it is apparent that the agriculture of the island lacks the kind of balance that would insure lasting strength and stability in an economy. Such a balance could be achieved to a considerable degree through more effective use of all available land resources and application of modern production know-how so as to expand both the volume and the variety of products produced for local consumption and for outside shipment. With the large population and the great dependence on imports, the big opportunity for local farmers and other landowners exists in expanding production among those commodities that will contribute most to making the island more nearly self-supporting, especially in food. The need is so great that anyone with even a small plot of land can make a substantial contribution by effectively utilizing it for producing more of the required foods.

Puerto Rico has long been dominated by the idea of producing for export. This has prevailed in every sector of the economy—in governmental, educational, banking, and business institutions as well as among farmers and workers—ever since the Spanish settlers first engaged in farming on the island. Even in more recent years, this producing-for-export complex has, like a pair of blinders, largely controlled the breadth of vision

in shaping the economy. As a result, relatively little has been done to meet the demands for local consumption, or even to encourage home food production by gardening or other means. Most of the attention and organizational effort has centered on the growing of sugarcane and the production of sugar for shipment out of the island. Unlike those in the sugar industry, growers of other crops that could be marketed outside did not gear their operations to changing conditions through the adoption of improved production and marketing methods. Most farmers tended to ignore producing for local consumption because of the lack of necessary incentives and facilities, and the gap left by their default had to be filled as much as the island could afford by shipments from mainland and other sources. Thus the production of pineapples and some different crops other than sugar that could be sold in outside markets has either deteriorated or else remained virtually static at low levels; the output of farm products for local consumption has continued to lag far behind the needs of the population. It is in this setting that sugar is the island's leading export commodity, utilizing a little less than half the cropland and contributing just over half the total value of all agricultural production.

The Existing Dependence on Imports

Although the growing of sugarcane utilizes most of the best of the agricultural resources in Puerto Rico, it is significant that the total income derived by farmers from this crop does not equal the total expenditure for food and feed that has to be imported for human and animal consumption. In 1950-51 the island spent roughly 125 million dollars for imported food and feed, about 88 percent of the total shipments coming from the United States mainland (table 36).

These imports amounted to an expenditure of approximately \$56 per capita, while the gross farm income from sugarcane alone was equivalent to a little more than \$48 per capita. And even with this volume of imports brought in at high cost to supplement local food and feed production, most of the people and the livestock remained poorly fed.

Out of the total spent for imported food and feeds, the biggest expenditure for any group of items went for grains, cereals, grain preparations, and feedstuffs. This totaled slightly more than

Table 36.—Volume and value of imported foodstuffs, fodder, and feeds, 1950–51

Product	From United States		From foreign countries		Total imports	
	Amount	Value	Amount	Value	Amount	Value
	<i>Pounds</i>	<i>Dollars</i>	<i>Pounds</i>	<i>Dollars</i>	<i>Pounds</i>	<i>Dollars</i>
Meats and meat products.....	42,478,790	13,444,549	10,990,944	2,500,683	53,469,731	15,945,232
Fats and oils, animal.....	52,913,390	9,367,918	145,650	36,669	53,059,040	9,404,587
Milk and milk products.....	184,764,187	13,580,008	33,646,580	1,190,398	218,410,767	14,770,406
Fish and fish products.....	5,266,117	1,100,109	35,804,087	4,788,237	41,070,204	5,888,346
Eggs in the shell.....	6,207,561	1,943,700	2,250	728	6,209,811	1,944,428
Eggs, dried, etc.....	990,297	764,443	-----	-----	990,297	764,443
Other animal products.....	15,235	103,368	-----	-----	15,235	103,368
Grains and preparations.....	443,775,622	34,507,204	3,810,190	1,588,555	447,585,812	36,095,759
Vegetables and preparations.....	197,749,230	13,727,128	35,753,168	929,097	233,502,398	14,656,225
Fruits and preparations.....	11,049,960	14,484,215	212,595	89,575	11,262,555	4,573,790
Nuts and preparations.....	700,839	210,239	18,923	1,420	719,762	211,659
Fats and oils, vegetable.....	7,100,147	1,843,411	1,631,968	541,757	8,732,115	2,385,168
Beverage materials.....	1,771,851	989,377	5,015,628	2,882,033	6,787,474	3,871,410
Spices.....	233,611	126,183	12,720	1,337	246,331	127,520
Sugar and related products.....	6,539,902	2,006,181	169,274	152,086	6,709,176	2,158,267
Beverages.....	(²)	5,045,605	(⁴)	858,919	(^{4 2})	5,904,524
Hay.....	241,920	5,306	1,202,000	13,392	1,443,920	18,698
Cottonseed.....	2,240	105	493,920	8,393	496,160	8,498
Soybeans.....	207,320	17,225	-----	-----	207,320	17,225
Mixed dairy and poultry feeds.....	118,973,120	4,970,850	3,506,000	125,002	122,479,120	5,095,852
Oyster and other shells for feed.....	29,120	290	-----	-----	29,120	290
Other prepared and mixed feeds.....	13,767,040	537,385	-----	-----	13,767,040	537,385
Corn feeds.....	13,189,120	542,280	-----	-----	13,189,120	542,280
Wheat feeds.....	407,680	11,022	-----	-----	407,680	11,022
Other feeds.....	2,808,960	68,550	-----	-----	2,808,960	68,550
Malt sprouts and brewers grains.....	-----	-----	107,520	2,639	107,520	2,639
Total.....	1,111,183,349	109,396,651	132,523,414	15,710,920	1,243,706,763	125,107,571

¹ Includes value of pineapple, grapefruit and other fruit juices which amounted to 2,845,107 gallons.

² Imported beverages from United States amounted to 5,498,888 gallons.

³ Includes value of olives in brine and not pitted, and pitted olives which amounted to 68,867 gallons.

⁴ Beverages amounted to 311,555 gallons.

\$42,187,000. Most of the products required could not be produced in Puerto Rico, but by increasing the output of those now being grown and by adding those that could be produced, it would be possible to save considerably on total imports. In the case of feedstuffs, for example, the cost of imports exceeded \$8,532,000. This large feed bill could be reduced substantially by improving pastures, increasing low yields of corn and other grains now being grown, and utilizing molasses and also other materials suitable for feed but which now are largely permitted to be wasted.

Meats make up the second largest group among the food and feed imports. The expenditure for meats shipped into Puerto Rico in 1950–51 exceeded \$15,945,000, and was the equivalent of two-thirds of the farm value of the meats produced on the island. Incidentally, because of the lack of an adequate meat supply, imports of fish are rather high and total \$5,888,000. Meat production could be increased considerably merely with improved local pastures which would permit more

and better grazing for dairy cattle and thus supply greater quantities of both milk and beef. Additional supplies of meat could be obtained by feeding hogs to heavier weights and making some increase in the number of swine raised by more fully utilizing local sources of feed for these animals. Increased livestock production and slaughtering could also yield many valuable byproducts such as hides, besides making more animal fats and oils available to replace some now being imported. The expenditure for edible animal fats and oils amounts to about \$9,405,000, with an additional \$2,385,000 for edible vegetable fats and oils, some of which could also be produced from locally grown raw materials.

Milk products shipped into the island totaled \$14,770,000, and ranked next to meats in value of imports. The biggest single item in this group was dried whole milk, imported at a cost of approximately \$6,615,000. An additional \$3,081,000 was spent for imported evaporated milk. The heavy imports of these two milk products alone are equal

to about 45 percent of the farm value of all milk produced on the island. Increased production of milk in Puerto Rico would raise the fluid milk supply for the people and reduce the need for bringing in so much canned and dried milk, which costs more locally. With proper management and improved pastures to provide better feed for more cattle, a more adequate milk supply could be achieved with benefits both to producers and consumers.

Another large group of food imports consists of various fresh and prepared vegetables, dried beans and peas, potatoes, and others. The expenditure for these totaled \$14,656,000, and a large part of this amount could be saved by producing more of these products in Puerto Rico. This would be economically feasible. Expenditures for some of the more important vegetables and preparations that were imported included \$4,805,000 for dry beans, \$1,201,000 for white potatoes, \$2,400,000 for tomato paste and puree, and lesser sums for a long list of other items. Altogether, the cost of the imported vegetable products, including the dried beans and other legumes, is almost equal to the farm value of these commodities grown in Puerto Rico.

Imports of various kinds of fresh and processed fruits and preparations approximated \$4,575,000. Many of these items could not be grown on the island. Those being produced are not available in sufficient quantity to supply the demand. In the case of canned pineapple slices and juice, for example, a big share of the local market has been taken over by imports largely through the default of the industry on the island, which has concentrated on production for outside shipment and neglected the possibility of selling right at home.

Although egg production has been expanding during recent years, imports still supply a considerable part of the local market. The volume of eggs brought into Puerto Rico in 1950-51 was valued at more than \$2,700,000, the equivalent of 50 percent of the farm value of locally produced eggs. The island could consume far more eggs than are available from both local and outside sources if more were supplied from local sources and handled properly to insure good quality. Although local eggs are preferred in the market, there is no steady supply of the volume required. Most of the imports are shell eggs, the value of these approximating \$1,944,000.



Almost one-half of the food consumed in Puerto Rico is imported, mostly from the United States mainland. Requirements for many of the items could be more adequately supplied from local farms merely by adopting improved methods of production and marketing and with the help of some credit.

Of course, Puerto Rico always will have to import a large volume of a wide range of products, especially those which because of climatic or other conditions cannot be produced locally. But where products are involved that can be produced economically on the island, every effort should be made to do so. In the case of agricultural products, it is significant that the expenditure for imported foods and feeds in 1950-51 amounted to the equivalent of 60 percent of the value of all farm products produced on the island. The farmers of Puerto Rico have a big opportunity to narrow this wide gap by producing more food and feed for local needs. This would result in substantial savings to the economy with increased income for agriculture and local business and improved diets for the island's population.

One fact that cannot be overlooked is that food requirements in Puerto Rico go higher and higher each year as the population total increases. The reliance on food imports already takes a big slice out of the local economy and it has rapidly become greater. As long as increasing quantities of food have to be imported to meet the needs of an ex-

panding population, consumers will have to bear the burden through even higher costs. Unless purchasing power keeps ahead of rising costs, these people will be able to buy less food and the entire economy will suffer. By gearing their production more nearly to the needs of the local market and by increasing food output in home gardens, the farmers and others of the island can do much to prevent such serious consequences. This can be done without in any way undercutting the possibilities of producing for the outside market outlets.

Food Requirements and Actual Supply

The lack of balance that exists in agricultural production is reflected directly in the pattern of food consumption among the people of Puerto Rico. A large segment of the population is not properly fed. The average person lacks the foods required for a low-cost adequate diet (table 37). Even with the rather substantial imports of various foods in relation to local production, there is an inadequate supply of the products essential for a low-cost adequate diet. The greatest deficiencies

are in those classes of foods which have long been largely regarded as incidental and residual in the agricultural development of the island. These include the protein foods such as milk, meats, and eggs, and the protective foods such as citrus fruits, tomatoes, and the green and yellow vegetables. In fact, the local production of most of these particular foods is so inadequate in relation to total population that the island cannot financially afford to import them in the quantities required for a decent level of nutrition. Since imported foods are high priced, only a small part of the population has enough purchasing power to buy them so as to supplement local supplies. This means that most of the people are largely dependent on the foods that come from island sources. Since the so-called protective and protein foods are produced locally in such relatively small volume, the needs of the average person are not being satisfied.

The average diet is heavily loaded with starches derived mainly from native-grown starchy vegetables, such as green bananas and plantains, and from grains and cereals, especially rice, which are

Table 37.—Food requirements and quantity available for consumption in Puerto Rico, 1950–51

Food group	Annual requirements for a low-cost adequate diet		Amount available for consumption 1950–51				Deficit or surplus in 1950–51 total requirements
	Per capita allowance ¹	For 1950–51 population ²	Locally produced ³	Imported	Total	Per capita	
	<i>Pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>1,000 pounds</i>	<i>Pounds</i>	<i>1,000 pounds</i>
Milk and milk products (exclusive of butter, milk equivalent basis).....	⁴ 458	⁴ 1, 012, 906	327, 155	213, 643	540, 798	245	— 472, 108
Eggs and egg products (fresh egg equivalent basis).....	18	39, 798	13, 685	7, 200	20, 885	9	— 18, 913
Meats, poultry and fish.....	52	114, 972	55, 048	53, 454	108, 502	49	— 6, 470
Rice, flour and cereals.....	⁵ 175	386, 925	49, 051	378, 575	427, 626	193	+ 40, 701
Starchy vegetables and fruits (<i>viandas</i>).....	365	807, 015	545, 404	99, 364	644, 768	292	— 162, 247
Yellow, green, leavy, and other vegetables (fresh and processed).....	75	165, 825	39, 464	26, 303	65, 767	30	— 100, 058
Citrus and other fruits, including tomatoes (fresh and processed).....	65	143, 715	83, 412	34, 731	118, 143	53	— 25, 572
Legumes and nuts ⁶	50	110, 550	21, 986	63, 776	85, 762	39	— 24, 788
Fats and oils.....	38	84, 018	2, 646	61, 154	63, 800	29	— 20, 218
Sugar and related products.....	50	110, 550	(⁷)	(⁷)	(⁷)	⁷ 100	(⁷)
Total.....	1, 344	⁸ 2, 865, 724	⁸ 1, 137, 851	⁸ 938, 200	⁸ 2, 076, 051	939	⁸ — 789, 673

¹ From estimates by the Bureau of Home Economics and Human Nutrition, U. S. Department of Agriculture.

² Computed on the basis of 2,211,000 population.

³ Estimated by the Department of Agriculture of Puerto Rico.

⁴ Would furnish 1.5 pints of milk per day for children and 1.5 cups per day for adults.

⁵ Rice represents 150 pounds of the total per capita requirement; the remaining 25 pounds consists of grain products, including flour.

⁶ Includes all beans, peas, and nuts as well as coconuts.

⁷ No figures were computed for sugar and related products because the supply is plentiful since Puerto Rico is a big producer of sugar for outside shipment. Nevertheless, it is estimated that per capita consumption is at least twice the amount specified as required for a low-cost adequate diet.

⁸ Exclusive of sugar and related products.



Among the foods produced in Puerto Rico, the starchy vegetables make up a big part of the foods consumed. These include the roots and tubers, bananas, and plantains. Changes in dietary habits are gradually being brought about, however, through educational means and by a rising level of income.

mostly imported. Sugar consumption is also relatively heavy.

In order to provide a low-cost adequate diet for the population of Puerto Rico, the total available supply of many of the foods that are now deficient would have to be increased very materially. To meet consumption requirements from local production, the volume of milk produced would have to be more than tripled. The production of eggs would also have to be increased considerably to furnish the needed supply per capita. And the people of the island could advantageously use far greater quantities of locally produced

meat. The production of protective fruits and vegetables would at least have to be increased by approximately $2\frac{1}{2}$ times to meet the requirements of a low-cost adequate diet. If the increased quantities of all these various protein and protective foods that are needed became available from local production, reductions could be made in some starchy foods which are now consumed to excess and the people would be more adequately fed.

A more diversified type of agriculture with increased yields and greater production per animal unit would do much to correct the deficiencies in

the diet of the population. At the same time, farmers would be able to enjoy the advantages of a local market that is not now being adequately supplied with the foods essential to a level of adequate nutrition. But even so, there still would be many people unable to obtain all of the kinds of food they need.

Although the general level of food production has been rising over the years, it has tended to level off and to decline in the years following World War II. The output has not kept pace with the requirements of an increasing population. Per capita food production has remained at a rather low and declining level during most of the years since 1930. During all this period, food output on the island has averaged, on a per capita basis, between one-fourth and one-third less than that indicated by the census figures beginning in 1910 through 1930.

The requirements for food in Puerto Rico have just about doubled in the period between the 1910 census and the 1950 census, since during that time there was that much of an increase in total population. Per capita local food production, however, is less than one-half that of the 1910 level although the quality has improved somewhat mainly by the expansion in the production of livestock products. Stretching the total production of food on the island over the entire population provided in 1950 about 515 pounds per capita as against 1,180 pounds in 1910. And, of course, as local food production per capita declined, imports had to be increased to make up for the difference to the extent that the island could financially afford to do so. Thus it is that nearly one-half of the food consumed on the island is represented by imports.

The full impact of the deterioration that has taken place in the per capita supply of locally produced food is not reflected by average figures. In Puerto Rico, as elsewhere, experience has demonstrated that dietary habits improve almost automatically as family income increases. Unfortunately, however, so many families on the island still have such low incomes that even under the most favorable circumstances it will take years to achieve any significant rise in the general level of nutrition by this route alone. The cold figures indicate that more than half the families do not earn enough in a year to provide an adequate diet even if they spent their full earnings for

food. The greater proportion of families in this category is to be found in the rural sections where the average number of mouths to be fed per household is greater and the level of income is lower than in urban areas. Yet, much can be done to improve nutrition among these families by encouraging self-help through increasing home food production and also making more effective use of the food that is available.

Of course, the nutritional problem in Puerto Rico has received a great deal of attention over the years. And considerable progress has been made to improve the situation through education and other means. However, with the population total at its present high level and increasing at a rapid rate, there is urgent need for strengthening and extending this work so as to reach more people more effectively with a strong program designed to overcome the existing shortcomings on the island's food front.

The people of Puerto Rico cannot afford to be complacent with the food supply situation that exists. Great emphasis must be given to increasing the production of such foods as milk, eggs, meat, and the protective fruits and vegetables so that more adequate supplies may be available in local markets to meet consumption requirements. Also, it must be recognized that there still will be need for additional production to satisfy the wants of those who do not have sufficient buying power. Many of these people are in a position to help themselves to improve diets simply by the use of their own energies and with little or no additional money outlay. A great deal can be done by increasing home food production—growing a garden, keeping a cow or goat, and raising a few chickens, or some rabbits.

There is a big need for more and better home gardens, and yet much of the land available to householders is not used for food production or else it is used ineffectively. Much of this land is in small plots, but no matter how little the patch may be it still can be made to produce some food and this should be encouraged to the maximum. Even on farms where there is plenty of land available, very few farmers maintain a good garden to supply the family table, and many of them do not even keep a cow or some chickens. In the towns and cities, where families have little or no land available to them, arrangements might well be made to help these people locate garden

space by making use of vacant lots or utilizing land on the outskirts of town. This could be done by the establishment of community gardens. Also, there is much opportunity for improvement in the utilization of the food supply that comes into the home as well as in the selection and buying of food. Wherever possible local community organizations should be developed and encouraged to promote greater understanding and self-help in the various ways that food production can be increased and diets improved in both the rural and urban areas.

Improving the Balance in Agriculture

Considering the needs of the economy and the requirements of the total population as against the actual level of output, it is clear that the land resources of Puerto Rico are not producing all they reasonably may be expected to yield with the know-how and means already available. Yet as long as the main emphasis in thinking and action is on production for shipment to outside markets, there is little prospect of any significant change in the existing agricultural pattern. Under the circumstances that prevail on the island, such a course can lead only to an even greater dependence on imports, further deterioration of resources, a lower rate of productivity per capita, and more acute social and economic problems than already exist. This prospect will have to be faced realistically by every segment of the population in both rural and urban areas. It emphasizes the urgent need for making more effective use of all available land resources, raising the general level of agricultural output, and diversifying production so as to cater to the demand that exists or which could be developed in the *total* market, both within and outside the island. This is the challenge that faces the farmers of Puerto Rico.

From the standpoint of the economy and the well-being of the people, no distinction should be drawn as between production for shipment to outside markets and production for the local markets. This has largely been true up to now with a resulting deadly inflexibility. When, for example, the outside market for a commodity declines, farmers of Puerto Rico generally are slow to shift to other products which they could produce either for shipment or local sale. Also, rather frequently products are produced almost exclusively for outside markets, and the local outlets are virtually

ignored so that supplies of the same or substitute products have to be imported at a higher cost for consumption on the island. In addition, there are several commodities that could be produced profitably in Puerto Rico to take the place of imports or provide supplies for outside shipment if farmers were made aware of these possibilities and responded by bringing them into production.

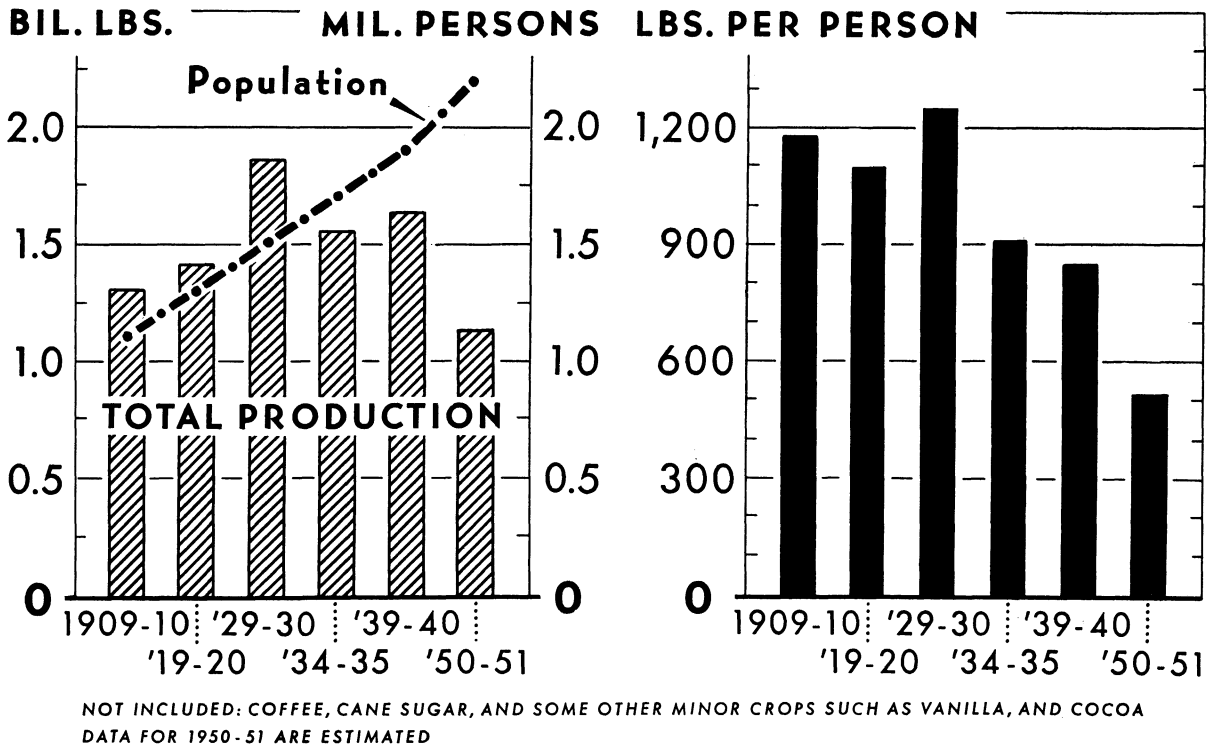
With good land use, greater diversification, and improved farming practices to lift yields from the present generally low averages, Puerto Rico could economically supply outside markets with greater quantities of some additional products and also produce far more for consumption and utilization on the island. Such a development would provide a firmer and broader base for the entire economy. This is very much needed. Increased production in a diversified type of agriculture geared to the demands of the *total* market would contribute much to raising the levels of employment and income for almost every segment of the population. With a greater variety and increased quantities of food and other products available from local sources, there would be less dependence on the more costly imports. Thus a stronger and more permanent foundation would be provided for the island's industrialization program with benefits accruing to all the people. The farmers of Puerto Rico would be well rewarded in all of this.

Moreover, producing more of the products that are needed for local requirements would go far to minimize Puerto Rico's disadvantages in the balance of trade with the mainland. Some of the disadvantages could then work to the advantage of production for local markets, with benefit to farmers and net savings to all the people. This is especially true in the case of agricultural commodities, particularly foodstuffs, which when imported must bear high transportation and handling charges, not counting the substantial markups that are added in the local sale of these products.

Although it is desirable to develop additional production for shipment to outside markets, the greatest emphasis possible should be placed on economic production that will more nearly meet the local needs for those commodities now being imported.

It seems reasonable to assume that the principal shipment of agricultural products to mainland and other outside markets will continue to consist of

PRODUCTION OF FOODSTUFFS and POPULATION, PUERTO RICO



Although the population of Puerto Rico doubled within the 40-year period between 1910 and 1950, the production of food on the island declined very sharply. The greatest reduction in food output came about during recent years, especially after World War II when a sharp expansion took place in the amount of land planted to sugarcane. The big decline in local food production has greatly increased Puerto Rico's dependence on food imports.

sugar and related products, tobacco, and some fruit and vegetable products. Although sugar leads by a very wide margin all other commodities shipped from Puerto Rico, there are legal limits on the volume that may be marketed. Production of sugarcane should, of course, be geared to supply the maximum tonnage of sugar that the island is capable of marketing in accordance with the quota set by the Sugar Act now or in the future. On this basis, the greatest opportunity for gains by the industry lies in greater efficiency and economy in the production and marketing of both cane and sugar.

In the case of tobacco, the market is also more or less limited by the declining trend in cigar consumption and by competitive factors. Other

cigar tobacco producing areas are up against the same problems. But the growers of tobacco in Puerto Rico can do a great deal to improve their position in the market and increase their returns by the adoption of more advanced practices that will raise both the yields produced and the quality of the leaf they sell.

For fruits and vegetables, either fresh or processed, there are only selective possibilities of increasing shipments to outside markets in any appreciable volume. United States consumers have a strong preference for temperate climate fruits and, despite many efforts, the development of a preference for tropical fruits, except for pineapples and fresh bananas, has been almost negligible. Nevertheless, Puerto Rico has certain advantages



The lack of agricultural diversification in areas where production should be diversified for the best use of land resources is evident in all parts of Puerto Rico. In this section near Cayey, for example, emphasis is on the production of tobacco and sugar, two export crops, and little or no attention is given to farm products for the local market. Producing both for export and local sale would go far to improve the balance of the island's agriculture and add to the total welfare of the economy.

over other tropical areas that could, if properly employed, make the island a more significant supplier of fresh and processed tropical fruits in the eastern half of the United States. This applies especially to pineapples and to fresh bananas. Markets for other fruits such as avocados and mangoes could be developed if adequate supplies of the improved varieties were produced and properly marketed. There also are limited possibilities in some specialty items in both canned and quick-frozen fruits and juices. The island could not, however, compete with mainland producing areas in supplying citrus products, except possibly limes. The same general situation exists for vegetables. There are times during the winter

months when Puerto Rico could market some vegetables on the mainland, but usually there is strong competition from both continental production and imports from Cuba and Mexico. Nevertheless, Puerto Rico could increase its volume of fresh vegetable shipments substantially if plantings were gaged so as to make up for indicated deficiencies in competing areas, and if improvements were made in production and marketing to assure good quality and appeal in the markets.

But since Puerto Rico now brings in so much of its food and feed supply and other products from the mainland, the biggest market potential for agricultural production is right at home. It is this outlet that needs to be supplied more ade-

quately from local production without necessarily curtailing the attention given to outside markets. Incidentally, increasing the production to more nearly meet the local requirement will place Puerto Rico in a stronger position to take advantage of outside markets whenever circumstances, such as a freeze in southern mainland producing areas, should develop that would make fresh produce shipments to northern sections worthwhile for the island. Also, outside markets could provide a good secondary outlet for various agricultural products, fresh or processed, which would be produced primarily to meet local needs.

Although the amount of land available for agricultural purposes is very limited, the island is fortunate in that crops may be grown every month of the year. This permits two or more crops to be produced in a year on the same acreage, depending, of course, on the length of growing period and the amount of moisture required by a particular crop. Where irrigation is available, moisture can be controlled. But in areas of the island wholly dependent on rainfall, the supply of moisture available for growing crops is determined by seasonal factors and production has to be adjusted accordingly. It is estimated that in 1950-51 a net area of 832,048 *cuerdas* (808,085 acres) actually was used for growing crops. The kind of crops grown would permit double cropping on 102,374 *cuerdas*. Crops were harvested from the equivalent of 894,361 *cuerdas*, or a net land area of 791,987 *cuerdas* (769,178 acres) after adjusting for double cropping. Still more land could become available for producing more than one crop a year if higher yields per acre were obtained which would permit less land to be used for crops requiring a long growing period. Also, additional cropping on tillable land would be possible if other land, most of it idle now, were put to more productive uses.

While an estimated net area of 832,048 *cuerdas* of land was actually used for crops in 1950-51, the cropping practices that were followed had the effect of raising this total to the equivalent of an estimated 934,422 *cuerdas* (table 38). The area occupied by sugarcane totaled 403,030 *cuerdas*, or about 45 percent of the cropland used. Coffee ranked second, and was spread over 173,247 *cuerdas*, or a little more than 20 percent of the total cropland actually employed. Altogether, the crops that have a long growing period, such as

sugarcane, coffee, tree fruits, bananas, plantains, pineapples, and some others that require most of a year or more to produce, took up a total of 756,540 *cuerdas*. The remaining land was utilized for other crops such as vegetables, tobacco, and grains which would permit double cropping under conditions in Puerto Rico.

Considering the acreage harvested and the production obtained, it is apparent that per acre yields are very low for a wide range of crops, and that there is room for considerable improvement in others. The big margin by which average yields can be raised should provide ample incentive for making more effective use of land resources and applying improved farming practices, especially in view of the potentialities of meeting a greater part of the local requirements as well as producing more for shipment to outside markets.

The shifts necessary to improve the present pattern of agricultural production so that the island may become more nearly self-supporting, will take initiative, time, and concerted effort. They will require some additional investments and many improvements in methods of producing, handling, and marketing farm products. But in the final analysis, with proper planning and the exercise of good judgment, the desirable changes that need to be made should be profitable to the farmers, helpful to the people, and beneficial to the economy. Of course there is risk involved, but this need not be greater than that in the usual business venture.

There can be no simple prescription for improving the pattern of agricultural production and the balance in agriculture in Puerto Rico. But the knowledge already available can provide the basis for constructive action and a reasonable level of attainment, crop by crop and enterprise by enterprise (table 39).

Since sugarcane growing is so important and now utilizes nearly one-half of the cropland of the island, anything that affects yields or the acreage devoted to this crop obviously has a significant impact. In a little more than a decade from 1938-39, the area of land devoted to growing sugarcane increased by about one-third to 403,030 *cuerdas* (391,423 acres) in 1950-51, and further to an estimated 420,000 *cuerdas* (407,904 acres) for 1951-52. The number of farms producing sugarcane rose 45 percent, from 11,380 in 1938-39 to 16,525 in 1950-51. During recent years, especially since the

Table 38.—Harvested area, production, and yield of crops in Puerto Rico, 1950–51 ¹

Crop	Harvested area	Unit	Production	Average yield
	<i>Cuerdas</i>			<i>Per cuerda</i>
Sugarcane.....	² 377, 979	Ton.....	10, 501, 396	27. 8
Tobacco.....	35, 028	100 pounds.....	255, 000	7. 3
Coffee.....	158, 237	do.....	172, 000	³ 1. 9
Beans, dry.....	28, 572	do.....	94, 286	3. 3
Pigeonpeas.....	27, 426	do.....	107, 079	3. 9
Cowpeas.....	3, 682	do.....	17, 672	4. 8
Grapefruit.....	1, 890	1,000 fruits.....	9, 703	5. 1
Pineapples.....	3, 054	Ton.....	27, 700	9. 1
Oranges.....	22, 000	1,000 fruits.....	185, 030	8. 4
Avocados.....	8, 000	do.....	36, 457	4. 6
Citrons.....	1, 000	do.....	6, 800	6. 8
Mangoes.....	3, 878	do.....	59, 192	15. 3
Coconuts.....	15, 000	do.....	23, 187	1. 5
Sweetpotatoes.....	28, 010	100 pounds.....	792, 685	28. 3
Cassava.....	4, 036	do.....	90, 807	22. 5
Taniers.....	18, 757	do.....	333, 873	17. 8
Yams.....	8, 016	do.....	252, 516	31. 5
Dasheens.....	7, 665	do.....	199, 301	26. 0
Plantains.....	17, 666	1,000 fruits.....	117, 268	6. 6
Bananas.....	41, 270	do.....	1, 320, 654	32. 0
Breadfruit.....	5, 878	do.....	53, 842	9. 2
Corn.....	50, 669	100 pounds.....	329, 347	6. 5
Rice.....	5, 212	do.....	28, 664	5. 5
Cotton, unginne.....	3, 946	do.....	11, 405	2. 9
Tomatoes.....	2, 774	do.....	173, 081	62. 4
Peppers.....	1, 523	do.....	64, 130	42. 1
Cabbage.....	1, 792	do.....	155, 192	86. 6
Squash and pumpkins.....	1, 951	do.....	188, 656	96. 7
Other vegetables.....	9, 450	do.....	-----	-----
Subtotal.....	⁴ 894, 361	-----	-----	-----
Area in sugarcane not harvested.....	25, 051	-----	-----	-----
Area in coffee not producing yet.....	15, 010	-----	-----	-----
Total.....	⁴ 934, 422	-----	-----	-----

¹ Estimated by the Department of Agriculture of Puerto Rico.² Area planted to sugarcane was 403,030 *cuerdas* but the area actually harvested was 377,979, that is, 25,051 *cuerdas* were carried over.³ The yield per *cuerda* for coffee was computed on the basis of 92,667 net *cuerdas* (90,000 acres) in coffee.⁴ Due to double cropping the net area of land actually used for crops totaled an estimated 832,048 *cuerdas* of which 791,987 *cuerdas* represented the net area of land from which crops were harvested.

end of World War II, the growing of sugarcane has spread out over the island into the more hilly sections and onto sloping lands of the interior regions. These areas are not as well adapted to cane growing as are the alluvial soils of the coastal plains. Since the amount of sugarcane now grown in the hilly and sloping sections is substantial, the relatively lower yields obtained in some of these areas tend to weight down the average for the island. Most of the sugarcane in the upland areas is produced by smaller farmers who only recently started growing cane.

A large part of the increase that has occurred in recent years in the acreage devoted to the growing of sugarcane came about by shifting land use, mostly in the upland regions. In the main, this has been at the expense of other crops, especially

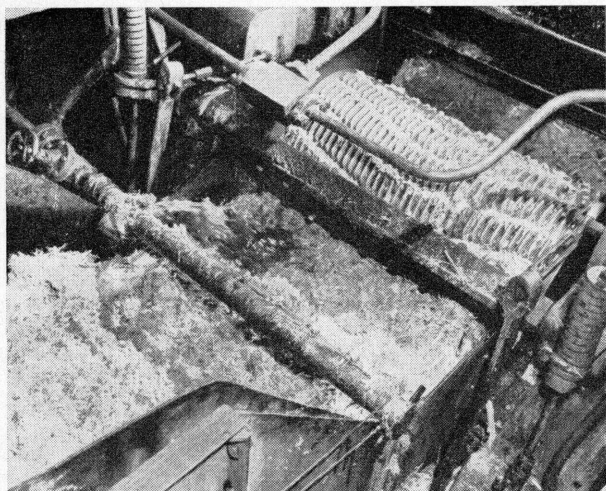
the food crops, which do not have the economic advantages of sugar. Pasture and forest lands have also been torn up to make way for the growing of sugarcane. At the same time, lands that properly could have been used for growing sugarcane remained poorly utilized or virtually idle.

Although it is very desirable for Puerto Rico to produce the maximum amount of sugar that may be marketed under the Sugar Act, the area of land employed for this purpose must be held to the practical minimum and the soils used must be those that are best adapted to growing sugarcane economically. At present, however, the production of sugarcane is on a more extensive basis than is warranted by the scarcity of land on the island and the know-how available for growing this crop. The quantity of cane produced and even

Table 39.—Actual 1950–51 production in Puerto Rico compared with proposed attainable production

Commodity	Unit	Estimated actual production 1950–51 ¹			Proposed attainable production			Percentage increase proposed attainable over actual 1950–51 production	
		Harvested area	Average yield per cuerda	Production	Harvested area	Average yield per cuerda	Production	Average yield	Production
		<i>Cuerdas</i>			<i>Cuerdas</i>			<i>Percent</i>	<i>Percent</i>
Crops:									
Sugarcane	Ton	377,979	27.8	10,501,396	300,000	40	² 12,000,000	43.9	14.3
Tobacco	100 pounds	35,028	7.3	255,000	23,500	11	258,500	50.7	1.4
Coffee	do	158,237	³ 1.9	172,000	123,000	³ 5.5	509,668	189.5	196.3
Oranges	1,000 fruits	22,000	8.4	185,030	48,000	15	720,000	78.6	289.1
Grapefruit	do	1,890	5.1	9,703	4,800	12.5	60,000	145.1	518.4
Avocados	do	8,000	4.6	36,457	16,000	9	144,000	95.7	295.0
Mangoes	do	3,878	15.3	59,192	8,000	28	244,000	83.0	278.4
Coconuts	do	15,000	1.5	23,187	15,000	3	45,000	100.0	94.1
Citrons	do	1,000	6.8	6,800	1,000	10	10,000	47.1	47.1
Pineapples	Ton	3,054	9.1	27,700	10,000	15	150,000	64.8	441.5
Sweetpotatoes	100 pounds	28,010	28.3	792,685	57,000	49	2,793,000	73.1	252.3
Yams	do	8,016	31.5	252,516	7,200	75	540,000	138.1	113.8
Taniers	do	18,757	17.8	333,873	15,000	38	570,000	113.5	70.7
Cassava	do	4,036	22.5	90,807	4,000	48	192,000	113.3	111.4
Dasheens	do	7,665	26.0	199,301	7,500	42	315,000	61.5	58.1
Bananas	1,000 fruits	41,270	32.0	1,320,654	42,000	50	2,600,000	56.2	96.9
Plantains	do	17,666	6.6	117,268	35,000	15	525,000	127.3	347.7
Corn	100 pounds	50,669	6.5	329,347	60,000	14	840,000	115.4	155.0
Rice	do	5,212	5.5	28,664	20,000	10	200,000	81.8	597.7
Beans, dry	do	28,572	3.3	94,286	48,000	9	432,000	172.7	358.2
Pigeonpeas	do	27,426	3.9	107,079	27,000	8	216,000	105.1	101.7
Cowpeas	do	3,682	4.8	17,672	6,000	6	36,000	25.0	103.7
Cotton, unginced	do	3,946	2.9	11,405	6,000	8	48,000	175.9	320.9
Tomatoes	do	2,774	62.4	173,081	12,000	85	1,020,000	36.2	489.3
Peppers	do	1,523	42.1	64,130	4,500	60	270,000	42.5	321.0
Cabbage	do	1,792	86.6	155,192	3,000	90	270,000	3.9	74.0
Squash and pumpkins	do	1,951	96.7	188,656	5,000	100	500,000	3.4	165.0
Other vegetables	do	9,450	(4)	(4)					
Onions	do	(4)	(4)	(4)	2,500	90	225,000		
Snapbeans	do	(4)	(4)	(4)	4,000	90	160,000		
Lettuce	do	(4)	(4)	(4)	2,000	100	200,000		
Sweetcorn	do	(4)	(4)	(4)	2,000	30	60,000		
Cucumbers	do	(4)	(4)	(4)	1,500	125	187,500		
Carrots, beets, etc	do	(4)	(4)	(4)	8,000				
Total crops		⁵ 888,483			⁶ 938,500				
Livestock products:									
Milk	Quart			⁷ 152,165,215			⁸ 447,674,418		194.2
Eggs	Dozen			⁹ 9,123,768			¹⁰ 26,041,700		185.4
Beef and veal	100 pounds			¹¹ 211,526			¹² 330,050		56.0
Poultry meat (chickens and broilers)	do			¹³ 84,000			¹⁴ 115,000		36.9
Pork, goat, and other meats and poultry	do			254,958			280,454		10.0

¹ Data from Department of Agriculture of Puerto Rico.² This exceeds by 1,500,000 tons the amount of cane normally required to fill the existing sugar quota plus possible deficits. This increase takes into consideration Puerto Rico's probable share in the future expansion of the United States sugar market.³ Yield computed on the basis of 92,667 net *cuerdas* in coffee.⁴ Unavailable.⁵ While the harvested area totals 888,483 *cuerdas*, the actual net amount of land used after allowing for double cropping equals 786,109 *cuerdas*.⁶ The harvested area of 938,500 *cuerdas* equals a net of 789,150 *cuerdas* of land actually used after allowance is made for double cropping.⁷ Based on an annual actual production estimated as averaging about 2,000 pounds of milk per cow from around 150,000 dairy cows.⁸ Based on a proposed attainable production averaging 3,500 pounds of milk per cow annually from 275,000 dairy cows.⁹ Estimated production from about 1 million chickens producing an average of around 100 eggs per year.¹⁰ Based on a proposed attainable production averaging 125 eggs per hen annually from 2,500,000 laying birds.¹¹ From an estimated slaughter of 80,000 head of cattle.¹² Proposed attainable production from annual slaughter of 125,000 head of cattle, including 40,000 cows culled from dairy herds, 52,000 calves, and 3,000 oxen and 30,000 other cattle from 150,000 head kept each year for purposes other than dairying.¹³ Includes production from an estimated 2 million broilers.¹⁴ Includes production from a proposed attainable 3 million broilers.



Grinding sugarcane in order to extract the juice is the first step in the highly mechanized internal operation of a sugar mill.

more of it can be grown on a smaller acreage than is now being utilized. So far as possible, sugarcane should be produced on the flat and gently rolling lands that are best adapted for growing this crop efficiently and at low cost. And in using less land for cane production, the tonnage needed could readily come by means of increasing average yields per acre through general use of improved varieties and cultivation methods and practices already developed and tested. The land thus released would then be available for other productive uses which would further benefit the economy.

Under the latest increase in quota provided by the Sugar Act, an increase first effective in 1953, Puerto Rico is able to market on the mainland a total of 1,080,000 tons of sugar annually. After allowing for local consumption and contingencies such as a reallocation of deficits in other areas that may reasonably be expected in the light of experience and Puerto Rico's probable share in the future expansion of the United States sugar market, Puerto Rico should grow about 12,000,000 tons of sugarcane in order to produce the volume of sugar that would be required. All of this sugarcane could be obtained from the harvest of 300,000 *cuerdas* if the average yields were brought up to around 40 tons per *cuerda*. This would compare with an average yield of 27.8 tons per *cuerda* (28.6 per acre) from 377,979 *cuerdas* (367,093 acres) harvested in 1950-51 which produced 10,500,000 tons of cane. A total of 330,000 *cuerdas* of cane would have to be grown, compared with 403,030 *cuerdas*

grown in 1950-51 and an estimated 420,000 *cuerdas* grown in 1951-52.

Attaining an average yield of 40 tons per *cuerda* should involve no particular difficulties. The mere use of higher-yielding varieties of sugarcane developed by the Puerto Rican Experiment Station would increase output per acre by from 15 to 30 percent on individual farms. At present these improved varieties occupy less than 5 percent of the total area planted to sugarcane. Proper use of fertilizers and application of more nitrogen, improved management by such measures as more frequent renovation of plantations, more effective weed control, protection against diseases and insects, and treatment of the seed pieces provide additional means by which per acre yields may be increased. In the case of nitrogen alone, tests have shown that many sugarcane growers could double the quantity of this plant food material now being used and both per acre yields and returns would be increased as a result. And as yields go up, less land is needed to produce the same total quantity of cane and more land then becomes available for the production of other agricultural products.

Less land could also be devoted to the growing of tobacco without reducing the total marketable supply. In 1950-51 there were 35,028 *cuerdas* of tobacco harvested which yielded 255,000 hundredweight, or an average of 7.3 hundredweight per *cuerda*. With care in the management of the land on which tobacco is grown, use of improved varieties, proper application of adequate quantities of fertilizers, control of diseases and insects, and improved methods of handling the crop, the average yields could be increased to at least 11 hundredweight per *cuerda*. With such a yield the tobacco acreage could be brought down to roughly 23,500 *cuerdas* which would produce 258,500 hundredweight of tobacco for market. Such a level of production is entirely practical. With the right kind of help and guidance among growers, it could be readily attained within a reasonable period. Increasing average yields will contribute materially to improving the quality of the tobacco. This quality can be maintained by utilizing more advanced methods of curing and handling the crop so as to improve market prices and returns to growers. With less land used to grow the tobacco they can market, the farmers will be able to add further to their income by

utilizing the released land for other productive purposes.

In the case of coffee, the main problem is to increase the yields from the acreage now planted to this crop. In general, the land already in coffee is best adapted for this purpose since most of it is steeply sloping and needs the protection that a tree crop can provide. The unified program for the rehabilitation of the coffee industry recently put into effect through the cooperation of the Federal and Puerto Rican Governments is demonstrating that yields can be increased very substantially by the use of improved cultural methods and the application of adequate quantities of the right kinds of fertilizers.

Although coffee production is spread over 173,247 *cuerdas* of land, it is estimated that the net area totals about 92,667 *cuerdas* (90,000 acres). The production in 1950-51 amounted to 172,000 hundredweight of coffee, or nearly 1.9 hundredweight per *cuerda*. The present net acreage in coffee should be maintained and improved so as to bring yields up to an average of at least 550 pounds per *cuerda*. This would result in a production of 509,668 hundredweight from the net of 92,667 *cuerdas* in coffee, or a little more than 200,000 hundredweight in excess of the island's requirements for local consumption. Weather during the blooming period is an important factor in coffee production. It has been usual for yields in Puerto Rico to go up one year and down the next because of the tendency toward alternate bearing of the coffee trees. The volume in excess of local consumption requirements would provide a margin of safety to insure adequate supplies of coffee for local use during off years.

Until the unified program for the coffee industry went into effect beginning in 1950, very few farmers used fertilizer or employed improved cultural practices to grow the crop. But as this program took hold and grower participation increased, the coffee plantations began to show signs of improvement. During the harvest of 1951-52, many growers found that yields from the acreage on which they had applied the improved practices under the program were double and even triple those obtained from the unimproved acreage. And possibilities for further increases in yields remain since the program does not include all cultural practices—such as insect and disease

control and use of improved varieties—that profitably could be employed.

Most of the land on which coffee is produced is planted with the native Arabica type. Recently there has been more interest in growing improved varieties, and some plantings have been made. These should be extended since tests made with the Columnaris variety at Mayagüez and Maricao produced coffee yields that were several times larger than those obtained from the native variety. At Maricao, with a planting distance 6 feet by 6 feet, the Columnaris variety yielded in 1951-52 (the third crop of the experiment) at the rate of 19.52 hundredweight of market coffee per acre. The average for the first three crops was 8.64 hundredweight or from four to five times the average yields that have been obtained on the island over many years.

With coffee production now spread out over 173,247 *cuerdas* of land but actually providing an estimated net of only 92,667 *cuerdas* in coffee, it is obvious that some of this total area is being poorly utilized. This would include land in coffee which has been neglected or abandoned and land with too few coffee trees either because of topographic limitations or failure to replant or space properly. Where it is possible to make more intensive use of this coffee acreage by improved plantings and management, this should be done. Otherwise, the land should be put to more productive uses, such as the growing of fruit or other tree crops by interplanting or otherwise. It is estimated that approximately 40,000 *cuerdas* of the total of 173,247 *cuerdas* on which coffee production is spread falls in the category of land that is now poorly utilized but which has good possibilities for more effective use.

The tree fruits should occupy an important position in the economy of the island, since they add so much to the total food supply. Unfortunately, however, most of the fruits are taken for granted, and very little is done to cultivate or care for the trees so as to make them really productive. Altogether, an estimated 51,768 *cuerdas* are devoted to oranges, grapefruit, avocados, mangoes, coconuts, and citrons. A few additional fruits such as limes or lemons, guava, papaya, West Indian cherries, and others are grown, but these are of minor importance although they do have commercial possibilities that remain untouched.



On many coffee farms in the mountains of Puerto Rico coffee beans are still piled high, raked down, and spread over the drying bed to dry in the tropical sun. The process takes several days to insure complete drying. When rain threatens, the beans are hurriedly gathered and temporarily brought under cover.

Oranges lead all other tree fruits on the island. The harvested area in 1950-51 amounted to an estimated 22,000 *cuerdas* with a production of 185,030 thousand fruits, or 8.4 thousand fruits per *cuerda*. The oranges are produced mainly in the upland areas. Most of the production is scattered and plantings are frequently intercropped with coffee. The fruit is a local seedling type of wild orange that has a delicious flavor and is adapted for fresh consumption as well as for processing, including the manufacture of frozen orange juice concentrate, some of which is being produced on the island. Present plantings, however, are entirely inadequate to meet the requirements of the consuming population during a large part of the year.

The production of oranges for local consumption should be increased in Puerto Rico through more systematic plantings in the upland areas and improved care of the trees with some fertilization so as to increase yields. Planting more of the oranges in groves would greatly facilitate proper

cultivation. In addition to growing the local seedling wild variety, there is need for producing some of the improved cultivated varieties, especially for off-season harvesting. The seedling oranges are available mainly in the winter months, and few oranges are obtainable during the rest of the year. This gap could be filled by producing an orange of the late Valencia type which would supply fruit during the summer months. The growing of oranges in suitable areas of the south coast under irrigation could also be expected to help bridge this seasonal gap. Altogether, the island could effectively utilize production from 48,000 *cuerdas*, a little less than one-half of which would be oranges that would mature during what is now the off season. With reasonable care in growing and the application of some fertilizer to the trees, production could readily be increased to a minimum average of 15 thousand fruits per *cuerda*, which would supply 720,000 thousand fruits from 48,000 *cuerdas*. This would provide an adequate supply for fresh consumption as well

as for processing, and permit some shipments to outside markets, especially to nearby areas where oranges in either fresh or processed forms are not readily available.

Grapefruit is another citrus product that deserves more attention, and some increased plantings should be made in groves. Production on the island was first developed on a commercial basis for shipment to mainland markets. But from the beginning of the 1930's, the grapefruit groves have been permitted to deteriorate because of hurricane damage and intense competition from Florida and Texas fruits in continental outlets. As a result, most of the grapefruit plantings in Puerto Rico are in the last stages of decline. Unless new plantings are made in the very near future, supplies of grapefruit will almost have disappeared from local markets within less than a decade. The island produces a fine quality grapefruit, and production should be increased if no more than to meet local requirements for consumption in fresh form and for processing. Some of the fruit and processed products could also be marketed in nearby areas.

In 1950-51 grapefruit was harvested from 1,890 *cuerdas*, and production totaled 9,703 thousand fruits, or 5.1 thousand fruits per *cuerda*. The island could utilize the production of grapefruit from 4,800 *cuerdas*. With reasonable care and the use of some fertilizer in growing the crop, yields averaging 12.5 thousand fruits per *cuerda* should be readily attained. This would bring total production of grapefruit up to 60,000 thousand fruits.

Avocados are grown in various parts of the island with the trees scattered in backyards, along farm boundaries and field crop borders, and in coffee plantations. Most of the avocado trees are seedlings of the West Indian avocado. They vary in size and quality, and at present no standard variety is planted on a commercial scale. Fertilizer is rarely used in growing avocados. There is no spraying or dusting to control damaging insects or diseases. Fortunately, however, the avocado in Puerto Rico is not damaged by serious pests, as it is in other producing areas, for the West Indian fruitfly does not attack the fruit, nor is the seed attacked by weevils. However, root rot of avocado trees, caused by *Phytophthora cinnamomi*, is a serious disease. This makes necessary the selection of avocado planting sites on well drained and neutral or near neutral soils. No

pruning or other cultural practices are followed in growing avocados. Usually the tree is simply planted and the crop is harvested in due time.

The equivalent of an estimated 8,000 *cuerdas* of avocados were harvested in 1950-51. Production totaled 36,457 thousand fruits, or 4.6 thousand fruits per *cuerda*. The avocados are marketed for local consumption. The harvest season gets under way in July and reaches a peak during August, September, and October. Although there are varieties of avocados that produce excellent fruit during the winter months, very few of these have been planted. Puerto Rico could make good use of more avocados, but the supplies need to be available over a longer period of the year. If there are to be any substantial increases in plantings they should be in groves or orchards and be of the varieties that will mature during the winter months, now the off season for avocados on the island. Commercial plantings to make avocados available during a longer period of the year would more nearly meet the requirements of the local market as well as provide supplies that could be sold advantageously in outside markets.

On this basis, the island could produce around 16,000 *cuerdas* of avocados, and with care and fertilization it should be possible to obtain at least 9 thousand fruits per *cuerda*. This would result in a total production of approximately 144,000 thousand fruits, about one-half of which should be produced during the winter months and the remainder during the summer.

Mangoes grow almost wild in Puerto Rico. There are some plantings in orchards, backyards, and along roadsides and farm boundaries. No selected varieties of mangoes are grown in commercial groves or orchards on the island, but rather a mixture of types varying in size and quality. One of the most common types is the "Mayaguezano" which is more abundant in the western part of the island. In general, most of the mangoes produced on the island are of the fibrous types. No fertilizers or any cultural practices are used in growing mangoes. Insects and diseases are not controlled. The most dreaded enemy of the mango is the West Indian fruitfly, and this insect, for which no practical control is yet available, is permitted to cause great damage unhindered.

The harvest of mangoes in 1950-51 was equivalent to an estimated 3,878 *cuerdas*, from which a

production of 59,192 thousand fruits was obtained with an average yield of 15.3 thousand fruits per *cuerda*. There are a number of superior varieties of nonfibrous mangoes that possibly could be grown profitably in Puerto Rico for local consumption, for shipment to outside markets, and for processing, especially quick freezing of the sliced fruit, which makes a delicious product. Plantings of these selected varieties should be encouraged on a commercial basis in orchards. With such plantings, the island could devote 8,000 *cuerdas* to the production of properly cultivated mangoes and obtain an average yield of at least 28 thousand fruits per *cuerda*. This would result in a production of 224,000 thousand fruits.

Coconuts are produced mostly in groves planted on sandy soils along the coastal areas. The "varieties" growing are in the main unselected seedlings and could be improved materially through the practice of seed selection in order to increase yields and to produce the kinds of fruits desired for the different uses. Fertilizer is rarely used. Except for a limited amount of weeding, no cultivation practices are followed. Fortunately, constant destruction of diseased coconut palms has kept the groves in Puerto Rico almost free from bud rot, which is the most serious disease threat. No sprays or dusts are used to control insects or diseases.

During 1950-51 coconuts were harvested from an estimated 15,000 *cuerdas*. Production totaled 23,187 thousand fruits, or 1.5 thousand fruits per *cuerda*. The coconuts are grown both for local consumption and outside shipment. Some coconuts are processed locally and the products are sold on the mainland for use largely in the baking and candy industries. The present 15,000 *cuerdas* of coconuts should be maintained, but with higher yields. With some improvement in cultivation practices, including use of selected seedling replacements or improved varieties, and the use of fertilizer, yields could readily be doubled from present levels to an average of 3 thousand fruits per *cuerda*. This would result in a production of 45,000 thousand fruits, which would provide adequate supplies for all available outlets, including local consumption, manufacture of coconut products, and shipment of coconuts as well as the processed products to mainland markets.

Citrons are of some minor commercial importance, about 1,000 *cuerdas* being harvested in

1950-51. Production totaled 6,800 thousand fruits, or 6.8 thousand fruits per *cuerda*. Most of this fruit is produced in the upland regions around Adjuntas, although there are other areas of the island where this crop could be grown successfully but where production is now limited. Plantings could be made much more productive by the use of selected varieties, improved cultural practices, and the application of adequate amounts of the proper fertilizers. By using improved production methods, there should be little difficulty in raising yields to an average of about 10 thousand fruits per *cuerda*. This would result in a total production of 10,000 thousand fruits. Although costs of producing a hundredweight of citrons would be lower than at present, the industry would have to broaden its market outlets (including possible local processing of this fruit) so as to dispose of the greater volume. Otherwise less acreage could be devoted to citrons, which are now mostly shipped in brine to mainland markets.

The pineapple is a crop that definitely should play a more prominent role in the economy of Puerto Rico. Although some improvements have been introduced in the production of this fruit, the industry on the island has a long way to go to establish itself on a modern basis from the standpoint of both production and marketing. Many of the methods employed lag behind the advanced practices that are known to be beneficial and profitable. Puerto Rico can grow pineapples successfully for both local sale and outside shipment in fresh and processed forms only if yields per acre are increased from the present relatively low average levels—and with improvements in the handling and marketing of the crops so as to take full advantage of every market possibility on and off the island.

In view of the inadequate production methods now employed, there is ample opportunity for raising per acre yields by adopting more modern growing practices. This calls for more attention to the choice of varieties and selection of seed stock, for improving methods of cultivation and application of fertilizer, and for controlling insects and diseases. Many insects attack pineapples in Puerto Rico, but very little is being done to control them by the application of insecticides. Measures to prevent diseases are also limited.



Pineapples grow well in Puerto Rico, but not without the right kind of soil and the necessary care.

In 1950-51 the island harvested 3,054 *cuerdas*, which yielded 27,700 tons of pineapples, or 9.1 tons per *cuerda*. With the adoption of recognized and improved techniques of producing pineapples, there is little reason why yields in Puerto Rico could not be brought up to an average of at least 15 tons per *cuerda*. At the same time, total plantings should be brought up to at least 10,000 *cuerdas*, which would produce 150,000 tons of pineapples. With such a volume of production and proper organization for handling and marketing the crop, the island would have the foundation for a vigorous industry that could supply local and outside markets with high quality fresh fruit and the various forms of processed pineapple products. Pineapples require a heavy investment per acre to produce, and high yields are necessary under normal conditions to safeguard this investment and insure a profit.

Slightly less than 20 percent of the land used for crops in 1950-51 was devoted to the production of the so-called starchy vegetables, including

sweetpotatoes, cassava, taniers, yams, dasheens, breadfruit, and also bananas and plantains which are used on the island mainly for cooking while still green. These starchy products are grown in practically all parts of the island being intercropped and also produced in crop rotations.

Sweetpotatoes grow very well in Puerto Rico, but most of the production comes from small patches. Recently, interest has developed in growing this crop on a broader scale commercially. The white type of sweetpotato has been more commonly grown than the yellow-flesh type, but the area planted to the yellow-flesh type is being increased. The variety that is rising in popularity is UPR 3, a yellow-flesh type developed by the Agricultural Experiment Station. This variety of sweetpotato produces good yields, has fine quality, and is well adapted to either fresh marketing or canning.

Plantings of sweetpotatoes may be made in Puerto Rico at almost any time when there is enough moisture in the soil to permit the vine cuttings to take root. The propagating material

comes from the younger portions of older plantings. Seedbeds to produce the plants for transplanting in the field are not used on the island as they are on the mainland. The best yields of sweetpotatoes in the northern section of the island are obtained when new plantings are made during July and August, and in the western area the best yields are obtained from May plantings. Except for two or three weeding, little else is done by most farmers in growing sweetpotatoes. Many insects attack the sweetpotatoes, especially the sweetpotato weevil, but except for rotating the crops and selecting apparently insect-free propagating material, no chemicals are in general use to control the damage. Few diseases affect sweetpotatoes in Puerto Rico. Not many farmers use fertilizers in growing sweetpotatoes. The general practice is to plant sweetpotatoes in rotation with tobacco, cotton, or any other crop harvested to take advantage of the residues of the fertilizer previously applied. A field of sweetpotatoes is ready for harvest from 4 to 6 months after planting, depending on the variety grown. Harvesting is done largely by hand, the roots being dug with a machete and many of the sweetpotatoes are cut and bruised in the process.

At present the sweetpotatoes produced in Puerto Rico are used almost entirely for local consumption. There is no grading, and all types of roots bring the same price. The product is bought from the farmers by intermediaries and hauled to the different markets of the island. The recent establishment of a canning plant near Isabela provided an additional outlet for yellow-flesh sweetpotatoes which were canned both for shipment to outside markets and for local consumption. The plant, however, had difficulties in obtaining a continuous and adequate supply of the sweetpotatoes needed.

During 1950-51 a total area of 28,010 *cuerdas* of sweetpotatoes was harvested with a production of 792,685 hundredweight, or an average yield of 28.3 hundredweight per *cuerda*. With improvements in the production and marketing of the crop, Puerto Rico could profitably produce an increased quantity of sweetpotatoes for local consumption and for processing. During certain times of the year it would be feasible to ship fresh sweetpotatoes to outside markets, and substantial outlets also could be developed for the canned product if supplies were adequate. Since sweet-

potatoes are highly adapted to the growing conditions that prevail, Puerto Rico could successfully compete with producing areas on the mainland. With improvements in cultivation practices, greater use of fertilizer for growing the crop, control of damaging insects, especially the weevil, and use of more desirable harvesting practices as well as improved marketing methods, the island could advantageously produce 57,000 *cuerdas* of sweetpotatoes. Yields could readily average at least 49 hundredweight per *cuerda*. This would result in a production totaling 2,793,000 hundredweight. Most of the sweetpotatoes grown should be the yellow-flesh type, with plantings on a commercial basis in larger acreages. Preference should be given to the UPR 3 variety of yellow-flesh sweetpotato. In plantings made at Isabela by the Agricultural Experiment Station, this variety has yielded on an average 58.5 hundredweight per *cuerda*. This is almost twice the yields obtained from plantings of other varieties on the same soil type.

Yams (*Dioscorea* sp.) are produced mainly in the central part of the island, extending eastward and westward. Although several varieties are grown, only two are of economic importance. These are the "Guinea" and Florida varieties. The "Guinea" variety produces roots weighing 15 or more pounds each. The roots of the Florida variety are of the smaller sizes which are more desirable for market. New plantings are usually made in December and January, but early plantings are made in October and November. The seed consists of small whole yams or cuttings of the upper end of the yam, the weight of the seed used varies from 8 ounces to 1 pound. The yams are usually planted in widely spaced holes in steep soils. Some farmers use fertilizer, and make two or three weeding in caring for the crop. As soon as the yam plants start growing, stakes are placed so as to serve as supports. Few insects and diseases attack the yams to cause serious damage. The main injury is from white grubs which tunnel the roots and cause some loss, but no control measures are employed.

The area of yams harvested in 1950-51 totaled 8,016 *cuerdas* with a production of 252,516 hundredweight, or an average yield of 31.5 hundredweight per *cuerda*. Almost all of the production is consumed locally. A few medium-size roots are shipped to the mainland. By using improved

varieties, employing land that could be worked more easily, adopting better cultivation practices, and applying more fertilizer, yields could readily be increased to an average of around 75 hundredweight per *cuerda* and the total acreage reduced to 7,200 *cuerdas*. This would result in a production of 540,000 hundredweight of yams.

Taniers or *yautía*, is a crop that is grown for local consumption on almost any soil type with the exception of sandy soils. This crop, however, prefers clay soils containing rather large quantities of organic matter. Although several varieties are produced, the "Inglesa," a new variety, is spreading because of its high productivity. The crop is planted in the spring months when there is sufficient moisture for sprouting the rootstock that is used for seed. With a little care in weeding at the right time and the application of some fertilizer, a good crop may be harvested in 10 to 12 months after planting. The rhizomes, which are the desired product, are dug by hand and placed in bags ready for market.

The acreage of taniers harvested in 1950-51 totaled 18,757 *cuerdas* with a production of 333,873 hundredweight, or 17.8 hundredweight per *cuerda*. With some improved practices in growing the crop and use of more fertilizer and the new higher-yielding variety, production of taniers could be increased to an average of around 38 hundredweight per *cuerda*. The acreage could be brought down to about 15,000 *cuerdas*, resulting in a total production of about 570,000 hundredweight of taniers.

Cassava is a crop grown for local consumption and the manufacture of starch. The "Blanquilla" variety is inedible and is used only for starch. Of the edible varieties, the "Pana" produces roots of high quality but it is a low yielder. Brazil No. 1 is a rather new, improved variety and is increasing in popularity. Cassava is planted in parts of farms where other crops cannot be grown economically, although for optimum development this crop requires loose or sandy soils. Propagation is by means of cuttings about 1 foot in length with at least three buds. Most of the growers use no fertilizer on cassava. A weeding or two constitute the only cultivation. Few diseases or pests attack the cassava. The most important enemy is the lonchaeid fly, or *Centella*, which produces a larva that kills the shoot and stops the growth of the plant. No insecticides are

used to control this pest, although some growers pick the grubs by hand and destroy them.

The area of cassava harvested in 1950-51 totaled 4,036 *cuerdas* with a production of 90,807 hundredweight, or 22.5 hundredweight per *cuerda*. The area should be maintained at roughly 4,000 *cuerdas*, but yields could be increased with improved cultural practices and the application of fertilizer to an average of at least 48 hundredweight per *cuerda*. This would result in a cassava production totaling 192,000 hundredweight, providing greater quantities of cassava for local uses, which could include expansion of starch making for industrial purposes on the island.

Dasheens, or "*malanga*," are grown mostly on moist soils, and the roots are used for local consumption. After planting, there is virtually no cultivation of the crop, except a little weeding. No fertilizers are usually applied in the production of this starchy vegetable. Dasheens were harvested from 7,665 *cuerdas* in 1950-51, with a production of 199,301 hundredweight, or a yield averaging 26 hundredweight per *cuerda*. With greater care in cultivation and the use of some fertilizer, the production of dasheens could be increased to an average of 42 hundredweight per *cuerda*, and plantings could be held down to roughly 7,500 *cuerdas*, which would result in a total output of 315,000 hundredweight.

Bananas are important to Puerto Rico both as a crop and a food. Very few of the bananas, however, are grown in plantations. Most of the plantings are scattered or interplanted with coffee. The greatest volume is produced in the coffee region. Although bananas can grow in almost any soil type on the island, they do better in deep, fertile well-drained soils. Several varieties of bananas are planted in Puerto Rico, the most common being the Monte Cristo, Enano, and Gigante or Gros Michel. Greater standardization of varieties and an increase in plantation culture are needed, however, if banana production on the island is to achieve the higher level of commercial importance which could profitably be developed.

Few farmers follow cultural practices that are necessary in producing good yields of high quality fruit. Some fertilizer is used, but the applications are commonly inadequate. From two to three weedings are made with hand hoes. In some cases further weedings are made by chopping the adventitious growth with machetes and

cleaning around the banana stalks. Few farmers thin their plantings for the ratoon crops. Those who thin use a "coa" (a primitive sharp-edged digging tool) to eliminate surplus suckers, leaving two or three to produce fruit at varying intervals.

Many pests attack bananas in Puerto Rico, but the corm borer weevil (*Cosmopolites sordidus*, Germar) is the most dreaded of all. It infests the corm of the banana and reduces the life and productivity of the plants.

In many localities the borer is so abundant as to be a limiting factor in production. Other insects are locally distributed and usually do not cause much damage. The control of the corm borer is not difficult despite the fact that the weevil is so well protected during most of its existence. But control must start by planting seed that is free from infestation. Farmers who attempt to exercise some control over this pest clear away the outside infested portions of the corm, or seed, until the grub is found and the seed is apparently free from infestation; then it is immediately planted. Another practice is to put the seed into almost boiling water for a few minutes to destroy the eggs as well as the grubs in the corm. The Panama disease, or banana wilt, appears to be a limiting factor in the production of the Gigante or Gros Michel variety. This disease is caused by a fungus which is an occasional soil invader not requiring the host plant for a prolonged existence. Nothing is done to control this disease in Puerto Rico, but farmers try to keep it down by not bringing material from infested areas. The Sigatoka disease is also common in bananas grown in full sunlight, but no controls are employed.

During 1950-51 bananas were harvested from a total of 41,270 *cuerdas*. Production totaled 13,206,540 bunches averaging 100 fruits each. The yield averaged 32 thousand fruits, or 320 bunches, per *cuerda*. The present production of bananas on the island is not entirely adequate for local consumption requirements which include uses both as a starchy vegetable and as a fresh fruit. Few of the bananas produced on the island are shipped to outside markets; most of the crop is consumed locally. The grower sells his harvested bananas to intermediaries who in turn sell in the local markets or to other merchants for retailing to consumers. With improvements in the production and marketing of bananas, the farmers of Puerto Rico could step up their output and provide more

adequate supplies for local consumption as well as for outside shipment. However, more of the bananas would have to be grown in plantation plantings and properly handled so as to make commercial production more efficient and to produce the quality bunches required for fresh fruit shipment. Production of bananas could be expanded to about 52,000 *cuerdas*, and with improved cultivation, increased use of fertilizer, and control of insects and diseases it should not be difficult to achieve an average yield of 50 thousand fruits, or 500 bunches, per *cuerda*. This would result in a production of 2,600,000 thousand fruits, or 26,000,000 bunches averaging 100 fruits each. The total area would provide all the bananas required for local consumption and also make available a substantial volume for fresh shipment to outside markets and for developing additional outlets. Among the possibilities for development in Puerto Rico, if an ample supply of the fruit were assured, is the manufacture of dehydrated bananas and banana paste which could be shipped to outside markets for use as baby food and for other purposes.

Plantains grow about the same as bananas. Several varieties of plantains are produced, the most common being the "Enano," "Harton," and "Maricongo." Plantains usually receive more attention from growers than is given to bananas. More fertilizer and better cultivation practices are used. Plantains, however, are more susceptible to the corm borer weevil. An infestation will shorten the life of the planting so that, except on very rich soils, not more than two crops may be harvested without replanting. Bananas may produce a year or two longer, since they rarely become so heavily infested or show injury so promptly.

The area of plantains harvested in 1950-51 totaled 17,666 *cuerdas* with a production of nearly 4 million bunches averaging 30 fruits each. The average yield was 221 bunches per *cuerda*. All of the production is consumed on the island. Plantain is served as a cooked, starchy vegetable. With improved methods followed in growing the crop, including more plantains grown in plantations, increased use of fertilizers, and greater control over damaging insects and diseases, production of plantains could be increased to an average of at least 15 thousand fruits, or 500 bunches, per *cuerda* from around 35,000 *cuerdas*. This would produce 17,500,000 bunches of plantains averaging 30 fruits



Bananas and plantains are popular foods in Puerto Rico, but their quality is not improved by this locally common method of bulk marketing.

each. Such a volume would assure adequate supplies for local consumption and permit some shipments to outside markets where a demand for plantains from the island could be developed, especially among the large Puerto Rican population in New York.

Of the grains and cereals produced in Puerto Rico, corn and rice are the most important. Some grain sorghums are produced. Although this crop is of minor importance, it deserves more attention as a source of feed, especially for production in the drier areas where the rainfall is insufficient for corn.

Corn is planted in various parts of the island, but few farmers do very much to grow a good crop. Only a small number of farmers apply fertilizer

to the corn, these being a few larger growers mainly in the southwestern part of the island. The rest usually plant their corn after a crop such as tobacco is harvested, placing the seed near where the preceding plant stood so as to utilize any fertilizer residue. The Mayorbela, a variety of corn developed by the Puerto Rican Experiment Station in cooperation with the Federal Experiment Station at Mayagüez, is gaining favor in plantings. Another variety of corn, Diente de Caballo, yields as well as Mayorbela. However, there are several other varieties and mixtures that are still popular, but do not yield as well. In the tobacco region, corn is planted during the spring months when moisture is ample for growth. In such areas as the southwestern part of the island, where the rainy

season usually occurs in the autumn months, plantings are made during August and September. There is no preparation of the soil for growing corn on land where this crop follows tobacco. On other land, the soil is plowed, or otherwise turned over and harrowed once. As a general rule one or two weedings are given to corn plantings. There is no systematic cultivation of the crop as on the mainland. Methods of harvesting, shelling, and cleaning the grain need further improvement. There are no adequate facilities for drying the corn or for storing it to safeguard against spoilage and loss from damage by insects and rats.

Many insects attack corn in Puerto Rico, but the most damaging are the earworm and the *Laphygma* caterpillar. The earworm feeds on grains of corn while the ears are growing, and the caterpillar feeds on the plant itself at all stages of growth. Very little is done by farmers to prevent insect damage although control measures have been developed. Great damage is done to the corn by rodents. Rats, a well-distributed pest in Puerto Rico, cause much loss in corn fields, but very little is done to control rat damage. Some farmers use poisons in their fields, but because rats are so abundant and so highly mobile, their control by a few individuals is difficult. Most of the corn harvested is used for feeding on the farm and any surplus is sold on the local markets. Some farmers sell their field corn while still in the milky stage as green corn for human consumption, to take the place of fresh sweetcorn, which is seldom available although it can be produced.

As a result of the poor way in which corn is commonly grown on the island, the yield is low. In 1950-51 there was a total of 50,669 *cuerdas* of corn harvested with a production of 329,347 hundredweight, or an average yield of 6.5 hundredweight of corn per *cuerda*. With selection of better adapted land and use of improved cultural practices, especially tillage, adequate fertilizer and improved seed, Puerto Rico could produce 60,000 *cuerdas* of corn and obtain a yield averaging at least 14 hundredweight per *cuerda*. This would result in a production of 840,000 hundredweight of corn, which would go far toward increasing the output of animal and poultry products on the island without having to import additional quantities of expensive feeds.

The best variety of corn that so far has been developed for conditions in Puerto Rico is the

Mayorbela. In plantings made at Isabela by the Puerto Rican Experiment Station, this variety of corn has yielded up to 55 hundredweight per acre. Plantings on Coto clay land at Isabela yielded 14.5 hundredweight per acre as against an average yield of 10.6 hundredweight for other varieties of corn on the same kind of soil, an increase of 45 percent. The Mayorbela variety yielded at the rate of nearly 18 hundredweight of corn per acre on a 77-acre planting at the Lajas Substation where rainfall is much lower than at Isabela. In view of Puerto Rico's need for increasing feed production from its own resources, work in developing even higher-yielding varieties of corn should be continued. More attention is needed to the breeding of high-yielding hybrid varieties of corn adapted to growing conditions on the island.

Rice is one of the major foods in Puerto Rico, but the island produces the equivalent of only about 4 percent of the amount imported. The plantings are entirely upland rice with many varieties being grown, including native and mixed varieties. Much of the rice is produced in the tobacco area, the crop being planted after the tobacco is harvested. Where the rice follows tobacco, hardly any attention is given to soil preparation except for clearing the land of tobacco stalks and weeds before plantings are made. Very few of the farmers who grow rice apply any fertilizers. In the tobacco area the farmers rely on the fertilizer residues left from the tobacco crop to supply nutrients for the rice crop. Except for one or two weedings when the rice is planted in rows, the crop receives no care. The harvest is by hand, a knife being used to cut the spikes with a section of the stem. Threshing is done in a primitive manner by men walking or dancing over the bunches of spikes. No mechanical equipment is employed.

The acreage of rice harvested in 1950-51 totaled 5,212 *cuerdas*, which produced 28,664 hundredweight, or an average yield of 5.5 hundredweight per *cuerda*. Puerto Rico could produce a larger proportion of its total rice requirements by utilizing higher-yielding varieties, improving land preparation and cultivation practices, and applying enough fertilizer to make the crop grow. With plantings of 20,000 *cuerdas* properly handled, yields could be brought up to an average of at least 10 hundredweight per *cuerda*, which would

result in a total production of around 200,000 hundredweight of rice.

There are, also, possibilities for growing paddy rice in Puerto Rico which deserve to be studied. Indications are that with a suitable variety of rice, efficient land preparation, correct irrigation and cultivation practices, and favorable seasonal planting, yields averaging up to 20 hundredweight per *cuerda* could be obtained. Puerto Rico has considerable land on which paddy rice probably could be produced. This includes the salty land and the poorly drained clays to be reclaimed. Rice apparently could be grown in reclaiming salty land. The 10,481 acres of salty clays in the Lajas Valley area appear to be the largest block of land in Puerto Rico that may be suitable for growing paddy rice. A survey to determine the feasibility of growing paddy rice on the island and the soil and climatic areas suitable for this crop should be undertaken by the Puerto Rican Agricultural Experiment Station in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture.

Legumes such as beans and peas are also among the major food items consumed in Puerto Rico, but the amount produced is small compared with the volume imported. A total area of 59,680 *cuerdas* of dry edible beans, pigeonpeas, and cowpeas was harvested in 1950-51, and the output represented only about one-fifth of the total consumption.

Dry edible beans are planted in many parts of the island. They are used in rotation with other crops such as tobacco, and often are interplanted with corn. The white and red types of beans are grown. The most popular, however, is the white bean which has been produced on the island for centuries and is commonly known as "Blanca del País." The red type is exemplified by "Colorada del País," a productive bean. Recent selections of high yielding varieties such as Bonita and No. 1329, developed by the Puerto Rican Experiment Station, are increasing in popularity. When beans are planted in a rotation after other crops, there is no further preparation of the soil other than clearing the land of crop residue and weeds. The bean crop is rarely fertilized by farmers in Puerto Rico, especially when planting follows a previously fertilized crop such as tobacco. A hoeing or two is about all the tillage that a bean crop gets. Many insects attack the beans while grow-

ing, but farmers make no use of insecticides to control them. Bean anthracnose is the most common disease in the bean fields, and nothing is done to prevent the losses that occur. No mechanical equipment is used in harvesting the crop.

The area of dry edible beans harvested in 1950-51 totaled 28,572 *cuerdas* with a production of 94,286 hundredweight, or an average yield of 3.3 hundredweight per *cuerda*. Puerto Rico could produce a far greater volume of beans than is now being supplied, but in order to do this on an economical basis farmers would have to plant the new high-yielding varieties, follow improved cultivation practices, apply adequate fertilizer, and control insects and diseases with sprays or dusts. With proper growing methods, the harvested acreage on the island could be increased to around 48,000 *cuerdas* and average yields raised to about 9 hundredweight per *cuerda*. This would result in a production of 432,000 hundredweight of dry edible beans.

There is need to grow both white and red beans in Puerto Rico in order to meet consumer preferences. The recently developed Bonita, a white variety of bean, has yielded up to 17 hundredweight of dry beans per acre. Plantings of this variety made by the Experiment Station on Coto clay at Isabela yielded an average of 10.2 hundredweight per acre, which was 205 percent of the average yields from other varieties of beans on the same type of soil. More work needs to be done on the island to develop additional high-yielding varieties, especially varieties of red kidney beans that will be adapted to varying local conditions and produce more than those now being grown. Since beans are a short season crop, requiring from 75 to 90 days from planting to harvest in Puerto Rico, they can be made to fit very nicely in a rotation cropping system and thus contribute greatly to more effective land use.

Pigeonpeas are grown in scattered plantings and in small patches along farm boundaries and field borders, as well as in backyards. A number of varieties are produced but "Blanco No. 1," a selection made from "Blanco de Yauco" by the Puerto Rican Experiment Station, is increasing in popularity because of its high productivity. Pigeonpeas are grown with hardly any cultivation. Farmers rarely use any fertilizer on the crop. The general practice is to plant the seed and let it grow until the harvest. The most common insect

attacking pigeonpeas is the leafhopper. Although this pest can be controlled by the use of insecticides, farmers do nothing to prevent the damage. Most of the production of pigeonpeas occurs from December to April. Supplies in excess of home requirements are sold on local markets and some are canned commercially.

During 1950-51 a total of 27,426 *cuerdas* of pigeonpeas was harvested with a production of 107,079 hundredweight, or an average yield of 3.9 hundredweight per *cuerda*. Production of pigeonpeas could be maintained at about 27,000 *cuerdas*, but yields should be increased in order to make this crop more worthwhile. With some improvement in cultural practices, including use of fertilizer and higher-yielding varieties of seed, average yields could be increased to approximately 8 hundredweight per *cuerda*. This would result in a production of 216,000 hundredweight of pigeonpeas.

Cowpeas are grown in a few sections of the island where they are planted in rotation with tobacco and other similar crops. Only a few varieties are planted, the most common one being the Blackeye. No fertilizers are used, and growers rely on the fertilizer residues that may remain in the soil from a previous crop such as tobacco. No special effort is made to prepare the soil for cowpeas when they follow another tilled crop.

The area of cowpeas harvested in 1950-51 totaled 3,682 *cuerdas*. Production amounted to 17,672 hundredweight, or an average yield of 4.8 hundredweight per *cuerda*. With a little more attention to cultivation practices and some use of fertilizer in growing approximately 6,000 *cuerdas* of cowpeas, an average yield of about 6 hundredweight per *cuerda* could be achieved and production would total 36,000 hundredweight.

Cotton is a crop in two general sections of the island—the northwestern area from Vega Baja to Aguadilla, and the southwestern area from Cabo Rojo to Ponce and Juana Díaz. Each area has its own planting and harvesting seasons. In the northwestern section, the crop is planted during January, February, and March when rainfall is scanty, and harvested in July, August, and September when the weather is rainy. The crop in the southwest is planted beginning in August through the first part of October, and the harvest starts in January and extends into March. Production is confined to sea-island cottons which have a fiber

length varying from $1\frac{1}{2}$ to $1\frac{3}{4}$ inches. This cotton is grown for shipment to the mainland since no spinning facilities are available on the island. Most of the growers are small producers and most of the crop is marketed through a cooperative.

The plantings of cotton are commonly made by hand. The most common variety is the Monserrat Sea-Island. Soil preparation and cultivation practices in growing a crop of cotton generally fall short of the requirements for obtaining good yields. Although fertilizer is used, the applications vary and usually are inadequate. Some farmers apply the fertilizer 2 or 3 days before planting the seed if possible, while others make the application when the cotton plants have two pairs of leaves showing. All the fertilizer is applied by hand at one time. Where irrigation is used, the fertilizer is put on after a good irrigation. When the fertilizer is applied after the plants have two pairs of leaves, it is placed around the plants and covered with dirt. The crop is largely cultivated by hand, with hoes being used to make two or three weedings to keep weeds down until the cotton is ready for harvest. Most of the cotton grown is dependent on rainfall. Some irrigation is practiced in the Isabela area.

The pink bollworm is the most dreaded enemy of cotton growers in Puerto Rico. No other pest of cotton is so insidious in its injury. The caterpillar burrows into the boll. Since the infested boll remains on the plant and usually attains its normal size, the grower is not aware of damage until it is opened and the lint is found to be hard and valueless. Although farmers attempt to control the pink bollworm by burning or destroying cotton crop residues, more widespread and effective steps need to be taken to eradicate and control this menace. Such measures and practices have recently been developed by the Puerto Rican Experiment Station, but as yet they have not been put into effect generally enough to strengthen controls already employed. Another insect that causes some damage to cotton on the island is the leafworm. Very few farmers, however, use insecticides to keep down losses caused by insects.

Cotton production in Puerto Rico has varied greatly from one year to another. In recent years it has ranged from less than 2,000 up to more than 5,000 *cuerdas*. In 1942 the crop exceeded 10,000 *cuerdas*, and in 1930 it reached 20,000 *cuerdas*. But during most years the production of cotton

has hovered around recent levels. In 1950-51 the area harvested totaled 3,946 *cuerdas* with a production of 11,405 hundredweight of unginned cotton, or an average yield of 2.9 hundredweight of unginned cotton per *cuerda*. Although yields in other years have averaged somewhat higher, they nevertheless are considerably below those that could be attained on the island with proper cultural practices, use of pure and selected seed, application of adequate fertilizer, and more effective control of the pink bollworm and other damaging insects. Also, from the standpoint of improving returns from growing the crop, it is important that production be restricted to a single variety of high-yielding cotton of the staple length and quality demanded by the market.

With different varieties of cotton being grown, there is no uniformity either of staple length or quality. This makes marketing of the crop difficult. Moreover, there has been a decline in the demand for sea-island cotton, and the growers in Puerto Rico have not been able to find ready buyers for their production at prices reasonably in line with those for other types of cotton. The long-staple cotton now most favored is of the American-Egyptian varieties, and this will probably continue. If cotton production in Puerto Rico is to be placed on a more profitable basis, then the industry will have to make some important shifts and changes. In addition to utilizing improved methods and techniques in growing cotton, the greater part of the crop should be produced under irrigation so as to insure maximum yields from improved production practices.

Sea-island cotton should be grown only to the extent that outlets will absorb the production, and the growing of the crop in a producing area ought to be confined to one variety that will give the highest yields of the uniform staple length and quality of cotton desired by the markets. Also, tests should be completed to determine the adaptability of American-Egyptian cotton and the growing practices required to produce this type of cotton properly on irrigated land in Puerto Rico. If it is possible to produce American-Egyptian cotton economically under irrigation on the island, then the growing of this fiber should be confined to the best adapted and most desirable single variety. It is conceivable that the entire production of cotton in Puerto Rico may have to shift from the sea-island to the American-Egyptian type in order

to keep abreast of the market demands. Puerto Rico could devote approximately 6,000 *cuerdas* to the production of cotton, about one-half of the area being irrigated lands. By following the necessary good growing practices, the yield on non-irrigated lands should average around 8 hundredweight of unginned cotton per *cuerda* with an average of 12 hundredweight from irrigated lands. The total output from such a level of production would be around 60,000 hundredweight of unginned cotton. If only nonirrigated lands are used, production would total about 48,000 hundredweight from 6,000 *cuerdas*.

The production of green and other vegetables which are regarded as being protective foods is wholly inadequate for the needs of the people of Puerto Rico. Little more than 17,000 *cuerdas* of these vegetables were harvested in 1950-51. The total output is normally far short of what the markets could absorb at reasonable prices. Most important of the few vegetables grown on the island are tomatoes, cabbage, peppers, pumpkins, lettuce, cucumbers, okra, onions, eggplant, and stringless beans. Small quantities of other vegetables are produced, beets, carrots, chayote, sweet-corn, and radishes among them. Vegetable production is most important in the Isabela area in the northwestern part of the island, Jayuya in the central portion, and Villalba in the southern part. Some are planted in the northeastern section, especially around Río Grande.

In Puerto Rico several vegetable crops may be grown on the same ground during a 12-month period by planting another vegetable as soon as a harvest is completed. However, most of the vegetable crop is planted during the winter months, and other smaller plantings are made during other seasons of the year. Where production depends on rainfall, plantings in the winter months are most successful because during other seasons there is likely to be excessive rainfall and other adverse conditions. Throughout the year vegetables on the island are attacked by many insects and pests, but very few growers use any sprays or dusts to prevent losses. Although some chemical fertilizers are employed, their use is not general. Some of the growers apply animal manure when it is available and some use filter-press cake, which is the sludge obtained from sugar mills. These organic materials may be supplemented with side dressings of fertilizers when the plants are well established.

The manner in which vegetables are grown in Puerto Rico requires a great deal of hand labor, since most of the plantings are in small patches and there is no mechanization of production. With the exception of a very few shipments, mostly of tomatoes to continental markets, the vegetables grown on the island are consumed locally. Large quantities of produce spoil following improper handling, both on the farm and in the markets. The vegetables sold in the local markets are ungraded and this is reflected in the flat prices that farmers receive.

Improved high-yielding varieties have been developed by the Puerto Rican and Federal experiment stations and these agencies have supplied a great deal of information and know-how to make vegetable growing profitable in Puerto Rico. Despite these aids, most of the growers still cling to outmoded methods and practices that require a great deal of labor, make production costly, and result in low levels of productivity. Puerto Rico greatly needs to devote more land to the growing of vegetables and to increase the total output of these essential food products. But, this cannot be done economically in the way vegetables are now produced. There is need to decrease production costs and to increase yields.

Unless greater quantities of vegetables can be produced at a lower per unit cost so that adequate supplies are available to consumers continuously throughout the year and at reasonable prices, the levels of consumption that should be attained probably will not be achieved. This would be a loss to both farmers and consumers. To achieve lower producing costs, reasonable selling prices, and continuously adequate supplies, calls for material improvements in prevailing cultivation practices. These include use of better land for vegetable production, growing more vegetables in larger plantings (and under irrigation in the drier areas where excessive rainfall is not a hindrance), use of improved varieties of seeds, application of adequate amounts of chemical fertilizers, and control of insects and diseases by spraying and dusting. Also required are improvements in the methods of handling and marketing the products so as to minimize spoilage and to insure quality for the consumer and reasonable returns for the producer.

Production of vegetables in Puerto Rico should be aimed primarily at the requirements for local

consumption in both fresh and processed forms. But there also are some possibilities for shipments to outside markets, and these should not be overlooked. In general, although first consideration should be production for local use, plantings should also be gaged so as to place Puerto Rico in position to take advantage of situations developing in competing areas that would enable the island to supply any of the outside markets. To meet all of these requirements, total plantings of vegetables in Puerto Rico would have to be increased to nearly three times the 1950-51 production. This would mean raising the harvested area of all vegetables to approximately 44,500 *cuerdas*. With improved production practices and by growing more of the vegetables under irrigation, such an area should enable the island to produce a supply of vegetables adequate for fresh consumption, to provide certain kinds for commercial canning and other processing to the extent that this may be feasible for local use, and also to permit shipments of some fresh produce when it could be sold advantageously in outside markets. Plantings of all the vegetables should be made so as to provide ample supplies for local consumption and use throughout the year.

The biggest increase is needed in the production of tomatoes, since so much of the total volume used on the island is now being imported in both fresh and processed forms. Instead of the 2,774 *cuerdas* harvested in 1950-51, a harvested area of around 12,000 *cuerdas* is required. Most of this should be planted in irrigated areas where water for growing the crop may be regulated and where rains will not interfere with sprays or dusts that may be applied to control insects and diseases. Production of tomatoes should be adjusted to the needs for fresh consumption locally throughout the year, the processing of canned tomato products that may be sold on the island, and for possible fresh shipments to mainland and other markets during certain times of the year, especially the winter months. The production of all other vegetables would need to be at least doubled or tripled in order to meet the island's requirements for each. Expanded areas of these vegetables should also be in localities where irrigation is available so that they may be produced more efficiently and higher yields obtained through improved production methods and techniques.

No opportunities should be lost in developing crops and products that may be produced advantageously in Puerto Rico. This applies generally to the kinds of crops that could be produced profitably in the upland areas in addition to or in place of coffee or other crops without adding to the problem of soil erosion. Such are needed to make more effective use of the land resources and at the same time provide additional farm income. Experimental work on complementary crops, now being carried out on a limited scale, should be broadened and intensified so as to more nearly meet the need. More research of the kind being done at the Federal Experiment Station with vanilla, for example, is required to overcome the disease, insect, and other problems which now prevent the commercial growing of several adaptable crops. Although vanilla appears to be a promising crop for Puerto Rico, certain problems, the most important of which is the control of root rot, remain to be solved before production can become profitable. Among the other possible crops are cacao; spices such as nutmeg and black pepper; and vegetable oils from such sources as the African oil palm. Fruits such as guavas, West Indian cherries and others deserve greater attention in view of the market possibilities which might be developed.

Some promising work has been done at the Federal Experiment Station on the production of essential oils, the growing of insecticidal and medicinal plants, and the growing of kenaf for fiber to take the place of jute. This has already resulted in limited plantings of lemon grass and citronella grass which are proving commercially profitable on upland soils and deserve to be further stimulated. Kenaf has been found to grow well in the coastal areas of Puerto Rico, and limited commercial plantings should be encouraged so that economical methods for producing and processing this fiber may be perfected. Ornamental plants and flowers are being grown on the island successfully for commercial shipment to the mainland, but the output is limited. Increases in plantings should be encouraged in order to meet the demand.

Among the foods used on the island there are some that could be produced locally instead of being imported. This is especially true of potatoes which are grown in a very small way, but with low yields due to faulty cultivation practices and

the use of seed from locally produced potatoes or from purchase of ordinary table stock. The Puerto Rican Experiment Station has recently undertaken some tests of different varieties produced on the mainland, and promising results are being obtained. The plantings indicate that there already are certain varieties, such as the Kennebec, which appear adaptable to Puerto Rican conditions. Varietal and cultural work on potatoes should be continued on the island since this crop could become of commercial importance locally provided growers plant suitable varieties of disease-resistant and disease-free seed grown in northern potato-producing areas and employ necessary cultivation-practices.

A big part of the land resources of Puerto Rico, however, is not suitable for and should not be used for crop production. It is now pasture, mostly unimproved cleared pastures and some woodland pastures. There are about 730,000 acres of such grasslands. They are now only partially productive. Through a pasture improvement program, their productivity could be doubled or even tripled. This would provide a greatly increased supply of livestock feed and enable the island to maintain a larger number of animals, especially dairy cattle, to produce more meat and milk for the population. The improvement of grasslands to produce more and better pasture, silage, and soilage for livestock feeding is one of the major potentials for increasing production on the island. Of the 730,000 acres regarded as pasture lands, only about 664,000 acres are considered to be best suited for growing grass and forage for livestock feeding. This is the land on which pasture improvement practices such as liming, fertilizing, and reseeding need to be applied to increase livestock-carrying capacity and the production of livestock products.

The main emphasis in livestock production in Puerto Rico should be placed on dairying since the island could readily utilize a substantially increased supply of locally produced milk. This is evident from the large volume that is being imported at great cost. An increase in milk supply calls for keeping a larger number of dairy cows and increasing the production per animal.

In 1950-51, there was produced on the island somewhat more than 150 million quarts of milk with a farm value of \$21,455,000. The number of dairy cows was approximately 150,000, and pro-



An improved pasture such as this planting of tropical kudzu and molassesgrass provides an abundance of good feed for livestock.

duction averaged about 2,000 pounds of milk per animal. Although some of the dairy animals, especially those in the San Juan area, are good grades and purebreds, most of them are native stock with a little zebu or other improved blood. The main feed is derived from pasture and forages, and some concentrate supplement is added to the ration of milking cows, especially by those farmers who have the better herds. Few silos are used, although the number has been increasing in recent years. In the small dairies along the southern coast and in the central region, calves are left with the cows but in the larger dairies the calves are given fresh milk during the first 2 or 3 months. Two diseases which are important factors in reducing production are mastitis and foot rot. Very few dairymen treat their cows for mastitis. Other diseases, such as tuberculosis, infectious abortion, and anaplasmosis, are being effectively controlled through governmental campaigns. Anthrax is sometimes reported among cattle along the southern coast. Internal parasites are a problem, and many animals go un-

treated. Most of the dairy farmers keep no production records on their animals, and there is little weighing or butterfat testing of the milk that is produced.

Dairying has been growing in importance in the agriculture of Puerto Rico during recent years. It can and properly should become far more important to the economy. With more attention to herd improvement and management, better breeding through selection and use of artificial insemination, and widespread development of improved pastures, silage, and forage employing high-yielding nutritional grass and legume mixtures, it should be possible to bring about a substantial expansion in the dairy industry on the island both in terms of cattle numbers and the volume of milk produced. The number of dairy cows could be increased to at least 275,000 head and the yearly production of milk brought up to an average of around 3,500 pounds per animal. This would result in a total output of nearly 450 million quarts of milk. And with more cattle being kept there would also be an increase in the meat supply for

the local population. Dairy heifers and young stock for herd replacement and growth should total around 60,000 head.

On some farms of the island it is not feasible, for one reason or another, to keep dairy cows. Yet many of these farms have land available that could be best utilized by developing improved pasture for beef production which would also provide cattle for draft purposes. With improved pastures containing grass and legume mixtures, the number of cattle kept largely for meat production and draft power could total approximately 150,000 head, including replacements. In the long run, however, the number of cattle kept for the production of meat should be reduced in favor of further increasing the number of dairy animals.

Other classes of livestock also have a place in the agriculture of Puerto Rico even though they may not be raised in any large numbers. More goats, for example, could be produced for milk and meat by utilizing steep slopes and other lands which are not suitable either for crops or cattle. The number of swine could also be increased by making greater use of native root crops and byproducts for feed and employing leguminous and other green forage to improve rations and lower production costs. Feeding hogs to heavier weights will also increase the total output of meat and make

production more economical, especially if locally produced feed is utilized so as to reduce the need for feeding imported concentrates. More rabbits could also be produced economically to augment the meat supply.

The poultry industry in Puerto Rico could be expanded substantially to meet the local demand for poultry meat and eggs. In addition to greatly increasing the number and size of farm flocks, there is opportunity for a considerable increase in commercial poultry flocks both for egg and meat production. The average farm on the island has only a few chickens, mostly of native or mixed stock, and these usually are forced to shift for themselves with little or no attention to what they eat or how much they produce.

Egg production depends mainly on these small flocks since there are only a few commercial poultry farms. The production of eggs from farm flocks is low, especially where birds of nondescript breeding are kept, which is commonly the case. Comparisons show that the output per native bird averages under good management conditions about 80 eggs a year as against a yield of 150 eggs per bird from hens of the New Hampshire breed. Among the relatively few farmers who keep improved breeds of poultry, the most popular breeds are the New Hampshire, White



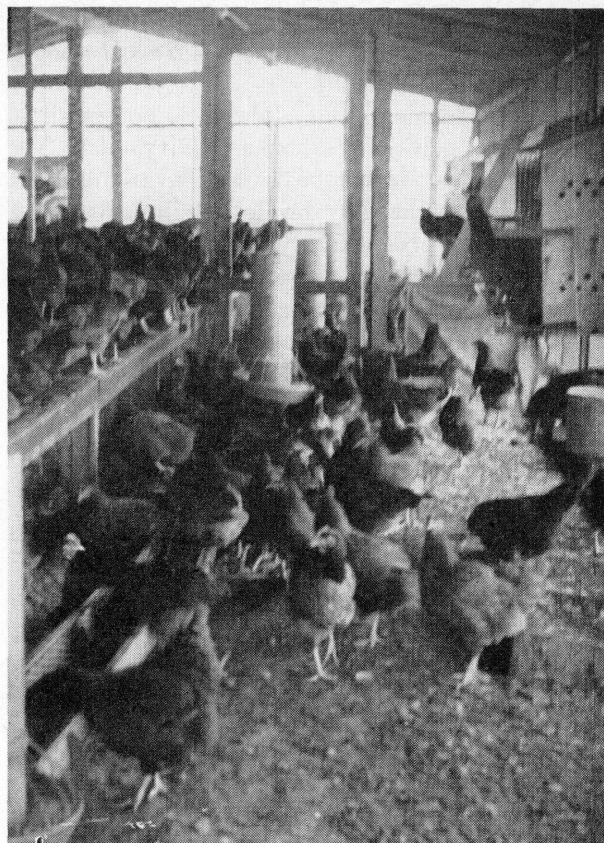
The further expansion and development of dairying in Puerto Rico deserves to be stimulated in order to make more effective use of land resources and increase local production of milk and meat, products now being imported at high cost in large amounts.

Leghorn, Plymouth Rock, and Rhode Island Red. These also yield considerably more meat than do the native birds.

The commercial production of broilers has been expanded considerably on an intensive basis since the end of World War II. Most of the production is in batteries housed in buildings located within or near the larger centers of population. The broilers are raised from baby chicks brought in from the mainland and also from fertile eggs that are shipped in and incubated on the island. Most of the broilers raised are sold by producers direct to consumers. Although the methods of raising broilers on the island are more advanced than those employed in egg production, they still are deficient in several important respects. Many improvements could obviously be made in the equipment used and in the growing and marketing practices employed so as to increase efficiency and lower production costs.

The number of chickens kept on farms in Puerto Rico has been increasing. The farm poultry population of about 2 million in 1951 was about three times the number of birds kept in 1935. In addition, many dwellers in and near towns and cities also keep a few chickens and these add up to a considerable number. The commercial broiler industry also produced in 1951 about 2 million birds.

Even though most of the feed used by the poultry industry in Puerto Rico has to be imported, the island could economically expand egg and poultry-meat production in view of the demand that is not being satisfied by local production. With both eggs and poultry meat being imported in considerable volume, Puerto Rican farmers have an opportunity to take over a good part of the market now being supplied from outside sources. In order to do so on a profitable basis, producers on the island would have to improve their production and marketing methods along with their facilities so as to increase efficiency and maintain costs at the lowest possible levels. In addition, farmers would have to keep in their laying flocks improved breeds of chickens so as to obtain a higher annual rate of egg production. With good management and feeding practices and the use of better stock, it should be possible for the poultry industry in Puerto Rico to maintain about 2,500,000 laying hens on farms and bring yearly production up



The poultry industry of Puerto Rico has been expanding during recent years, especially in the production of broilers. With good management, a far greater number of birds could be kept profitably on the island's farms in order to fill the demand for eggs and poultry meat.

to an average of about 125 eggs per bird. The broiler industry could well be brought up to a level so as to produce in the range of 3 million broilers a year.

More From the Land, More for the People

The proposed attainable levels of production for the various crop and livestock enterprises are realistically reasonable when measured against what has already been tried and tested on the island and in long practical experience elsewhere under similar climatic conditions. What can be accomplished rests largely on the ability of farmers to increase their yields from each *cuerda* of land and from each unit of livestock. In most instances the yields prevailing on the Island are so low that even a little improvement in production practices will go a long way toward boosting the output. Thus with no more than a reasonable

change in farming methods a great deal can be accomplished to increase production. And with the use of already available improved varieties and application of somewhat greater quantities of the right kinds of fertilizer, output can be raised still more without any appreciable extra labor. That is the sum and substance of what is required to achieve the proposed crop and livestock production levels. And if more care and attention is applied, the greater will be the real output.

Considering the shifts and improvements that need to be made, it is reasonable to expect that with sound guidance and determined effort the farmers of Puerto Rico should be able to reach the proposed levels of production in full within a period of from 10 to 15 years. Thus if this problem is attacked as it should be, farmers could achieve a reasonable and worthwhile improved balance in the island's agriculture by about 1965. When that is accomplished all the people in Puerto Rico will be getting a great deal more from the same land. At the same time, there will be a wiser use and management of the land so that future generations may also enjoy and profit from it.

The proposed attainable production pattern for crops, livestock, and livestock products would result in a substantial increase in the gross value of annual farm output. For a list of selected farm commodities, including practically all the items of any significance, the gain in farm value computed on the basis of 1950-51 prices exceeds by a little more than 73 percent the farm value of these same commodities in the amounts actually produced on the island in 1950-51 (table 40). The farm value of these selected crop and livestock products produced in 1950-51 totaled \$181,546,000 as compared with a total farm value of \$314,976,000 from the proposed attainable production computed at the same prices. The farm value of the selected crops, 27 of them including sugarcane, goes from \$141,524,000 in 1950-51 to \$216,877,000 from the proposed attainable production, an increase of 53 percent. The value of crops exclusive of sugarcane rises from \$35,145,000 to \$95,317,000, an increase of 171 percent. The farm value of selected livestock products, including milk, eggs, meat, and chickens, rises from \$40,022,000 in 1950-51 to \$98,099,000 from the proposed attainable production, a jump of 145 percent. In terms of money, the

increase in output that would result from the proposed attainable production pattern has but one meaning—more income for more people.

But equally important, if not more so, is the impact that the proposed attainable production pattern would have on the supply of food available for the population from the island's own land resources. The total output of all food products, including sugar, would be increased under the proposed pattern by nearly 72 percent over what was actually produced on the island's farms in 1950-51 (table 41). More striking, however, is the fact that the proposed pattern would result in an increase of 192 percent in the output of all food products not including sugar. This would provide not only more food for more people but also a surplus of some important farm commodities which would be available for shipment to outside markets in greater quantities than is now possible. And the island would still be producing and marketing all of the sugar that it possibly could under such limitations as might be imposed by continuance of the Sugar Act.

Excluding sugar, if the food output contemplated by the proposed attainable production pattern had been produced in 1950-51, the island's entire population of 2,211,000 people could have had available with some imports in exchange for exports, more than enough food to provide the average consumer with a low-cost adequate diet. Instead, the actual 1950-51 production made available to the people of Puerto Rico only about one-half of the food poundage needed for a low-cost adequate diet and the remainder required was left to be made up by imports to the extent that the consumers could afford them. And, as shown in table 37, the combination of actual 1950-51 production and heavy food imports did not provide the population with the food needed for a low-cost adequate diet. The proposed attainable production pattern is aimed at the particular problem of overcoming the great want that exists in the island's food supply so that the population may become more nearly self-supporting from its own land resources.

The population of Puerto Rico is continuing to increase at a rapid rate while food production has been lagging behind. More and more food will have to be imported in the future unless local production is increased to keep pace with the ex-

Table 40.—Farm value of 1950–51 actual and proposed attainable production

Selected crop or product	Unit	Farm price 1950–51 ¹	Farm value of 1950–51 actual pro- duction ¹	Farm value of proposed attainable production at 1950–51 prices	Percentage increase proposed attainable over 1950–51 farm value
		<i>Dollars</i>	<i>1,000 dollars</i>	<i>1,000 dollars</i>	
Sugarcane.....	Ton.....	10. 13	106, 379	121, 560	14. 3
Tobacco.....	100 pounds.....	24. 92	6, 355	6, 442	1. 4
Coffee.....	do.....	48. 85	8, 402	24, 897	196. 3
Oranges.....	1,000 fruits.....	3. 41	631	2, 455	289. 1
Grapefruit.....	do.....	16. 91	164	1, 015	518. 9
Avocados.....	do.....	17. 49	638	2, 519	294. 8
Mangoes.....	do.....	2. 82	167	632	278. 4
Coconuts.....	do.....	59. 53	1, 380	2, 679	94. 0
Citrons.....	do.....	30. 20	205	302	47. 3
Pineapples.....	Crate.....	1. 63	1, 290	5, 996	442. 3
Sweetpotatoes.....	100 pounds.....	1. 93	1, 530	5, 390	252. 3
Yams.....	do.....	2. 00	505	1, 080	113. 9
Taniers.....	do.....	3. 00	1, 002	1, 710	70. 7
Cassava.....	do.....	1. 53	139	294	211. 5
Dasheens.....	do.....	1. 43	285	450	57. 9
Bananas.....	1,000 fruits.....	3. 45	4, 556	8, 970	96. 9
Plantains.....	do.....	14. 64	1, 717	7, 686	347. 6
Corn.....	100 pounds.....	4. 15	1, 367	3, 486	166. 5
Rice.....	do.....	5. 99	172	1, 198	596. 5
Beans, dry.....	do.....	12. 48	1, 177	5, 391	358. 0
Pigeonpeas.....	do.....	10. 76	1, 152	2, 324	101. 7
Cowpeas.....	do.....	7. 01	124	252	103. 2
Cotton, unginned.....	do.....	13. 35	152	641	321. 7
Tomatoes.....	do.....	5. 16	893	5, 263	489. 4
Peppers.....	do.....	5. 67	364	1, 531	320. 6
Cabbage.....	do.....	2. 44	379	659	73. 9
Squash and pumpkins.....	do.....	2. 11	398	1, 055	165. 1
Total value selected crops.....			141, 524	216, 877	53. 2
Total value of crops, exclusive of sugarcane.....			35, 145	95, 317	171. 2
Milk.....	Quart.....	0. 141	21, 455	63, 122	194. 2
Eggs.....	Dozen.....	0. 5976	5, 452	15, 563	185. 5
Beef and veal.....	100 pounds.....	36. 07	7, 630	11, 905	56. 0
Poultry meat (chickens—broilers).....	do.....	65. 30	5, 485	7, 509	36. 9
Total value selected livestock products.....			40, 022	98, 099	145. 1
Grand total all crops and products.....			181, 546	314, 976	73. 5

¹ Estimated by the Department of Agriculture of Puerto Rico.

panding population. This is an obvious, simple fact. Up to now the island has not been in a position where it could afford to buy from outside sources all of the food needed for a low-cost adequate diet. This is reflected in the health and the condition of the people themselves. As the population grows and the dependence on imported foods increases, more and more people will be getting less and less until local production is increased. The proposed attainable production pattern is designed to meet the needs of Puerto Rico's rising population so that a minimum of food imports will be required to make up deficiencies in

the total supply necessary for a low-cost adequate diet for the greater number of people.

Looking ahead to the time when Puerto Rico will probably have a population totaling 3,000,000 people, perhaps by 1970 or sooner if a high rate of migration does not continue, the amount of food, exclusive of sugar, that would allow a low-cost adequate diet for such a population number totals 3,888,000,000 pounds as compared with 2,865,724,000 pounds for 2,211,000 people in 1950–51. The proposed attainable production pattern would provide more than 3,326,846,000 pounds as against a little more than 1,137,851,000 pounds derived

Table 41.—Food supply from actual and proposed attainable production as related to requirements

Food group	Annual re- quirements for a low-cost adequate diet based on 1950-51 total 2,211,000 population ¹	Local production			Balance between 1950-51 requirements and —		Annual re- quirements for low-cost adequate diet based on 3,000,000 population	Balance between proposed attainable production and require- ments based on 3,000,000 population
		Actual 1950-51 ²	Proposed attainable	Increase over actual 1950-51	Actual 1950-51 production	Proposed attainable production		
	1,000 pounds	1,000 pounds	1,000 pounds	Percent	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
Milk and milk products (exclusive of butter, milk equivalent basis)-----	1, 012, 906	327, 155	962, 500	194. 2	-685, 751	-50, 406	1, 374, 000	-411, 500
Eggs and egg products (fresh egg equivalent basis)-----	39, 798	13, 685	39, 062	185. 4	-26, 113	-736	54, 000	-14, 938
Meat, poultry, and fish-----	114, 972	55, 048	72, 550	31. 8	-59, 924	3 -42, 422	156, 000	3 -83, 450
Rice, flour, and cereals-----	386, 925	49, 051	95, 280	94. 1	-337, 874	-291, 645	525, 000	-429, 720
Starchy vegetables and fruits (<i>viandas</i>)-----	807, 015	545, 404	1, 486, 404	172. 5	-261, 611	4 +679, 389	1, 095, 000	4 +391, 404
Yellow, green, leafy and other vegetables (fresh and processed)-----	165, 825	39, 464	162, 040	310. 6	-126, 361	-3, 785	225, 000	-62, 960
Citrus and other fruits including tomatoes (fresh and processed)-----	143, 715	83, 412	373, 100	347. 3	-60, 303	5 +229, 385	195, 000	5 +178, 100
Legumes and nuts ⁶ -----	110, 550	21, 986	132, 735	503. 7	-88, 564	7 -22, 185	150, 000	8 -17, 265
Fats and oils-----	84, 018	2, 646	3, 175	20. 0	-81, 372	-80, 843	114, 000	-110, 825
Sugar and related products-----	110, 550	2, 476, 647	2, 880, 000	16. 3	+2, 366, 097	+2, 769, 450	150, 000	+2, 730, 000
Total-----	2, 976, 274	3, 614, 498	6, 206, 846	71. 7	+638, 224	+3, 230, 572	4, 038, 000	+2, 168, 846
Total without sugar and related products-----	2, 865, 724	1, 137, 851	3, 326, 846	192. 4	-1, 727, 873	+461, 122	3, 888, 000	-561, 154

¹ Based on per capita requirements estimated by the Bureau of Home Economics and Human Nutrition, U. S. Department of Agriculture.

² Estimated by the Department of Agriculture of Puerto Rico.

³ A substantial part of this deficit would be made up by imports of fish.

⁴ Would permit shipments to outside markets of such products as bananas, plantains, and sweet potatoes.

⁵ Would permit outside shipments of pineapples, some fresh tomatoes, avocados, mangoes, citrons, and some shipments of citrus products to markets in the Caribbean area.

⁶ Includes coconuts.

⁷ Surplus only in coconuts which would be available for outside shipment in even greater quantities since there would still be an actual deficit of beans and other legumes from local production.

⁸ Deficit represents beans and other legumes which would have to be imported in even greater quantities and thus displace coconuts which would then be available for outside shipment.

⁹ Computed on the basis of the 5-year 1947-51 average yield of raw sugar per ton of cane harvested. Does not include allowance for "normal carryover," since carryover is already built up. It does, however, provide for some excess which may be added to carryover plus 180,000 tons as Puerto Rico's probable share in the future expansion of the United States sugar market.

from 1950-51 actual production. Thus, although the proposed production pattern would fall short by 561,154,000 pounds in meeting the food requirements for a low-cost adequate diet for a 3,000,000 population, this deficit in total poundage of food exclusive of sugar would be considerably less than one-third the shortage of more than 1,727,873,000 pounds in the difference between 1950-51 actual production and food required to supply the same diet for the 2,211,000 people that had to be fed that year. More significant, how-

ever, is the fact that the proposed attainable production pattern would yield enough food from local farms so that a 3,000,000 population would still be eating more and better food than was available (from both actual production and imports in 1950-51) to the total of 2,211,000 people there were on the island. Moreover, once having made the changes needed to bring the proposed attainable production pattern into being, the way will have been paved for achieving even further increases in production so as to provide more from the land and more for the people.

Chapter XI

Marketing Farm Products

The pattern of agriculture prevailing in Puerto Rico is closely tied to the marketing system that has evolved since the first public market places were laid out near the plazas of the early settlements for the sale and distribution of imported foodstuffs and related items and the products from nearby farms. One is largely a reflection of the other. The functional aspects of marketing and the organizational structure needed to serve both producers and consumers have received scant attention. What has developed through the many years is a marketing system heavily burdened with inadequacies and an excess of intermediary handlers. The heavy toll exacted annually by this sort of inefficient structure has long restricted consumption and retarded production. This is a situation that has come to be accepted by force of custom and habit through many generations.

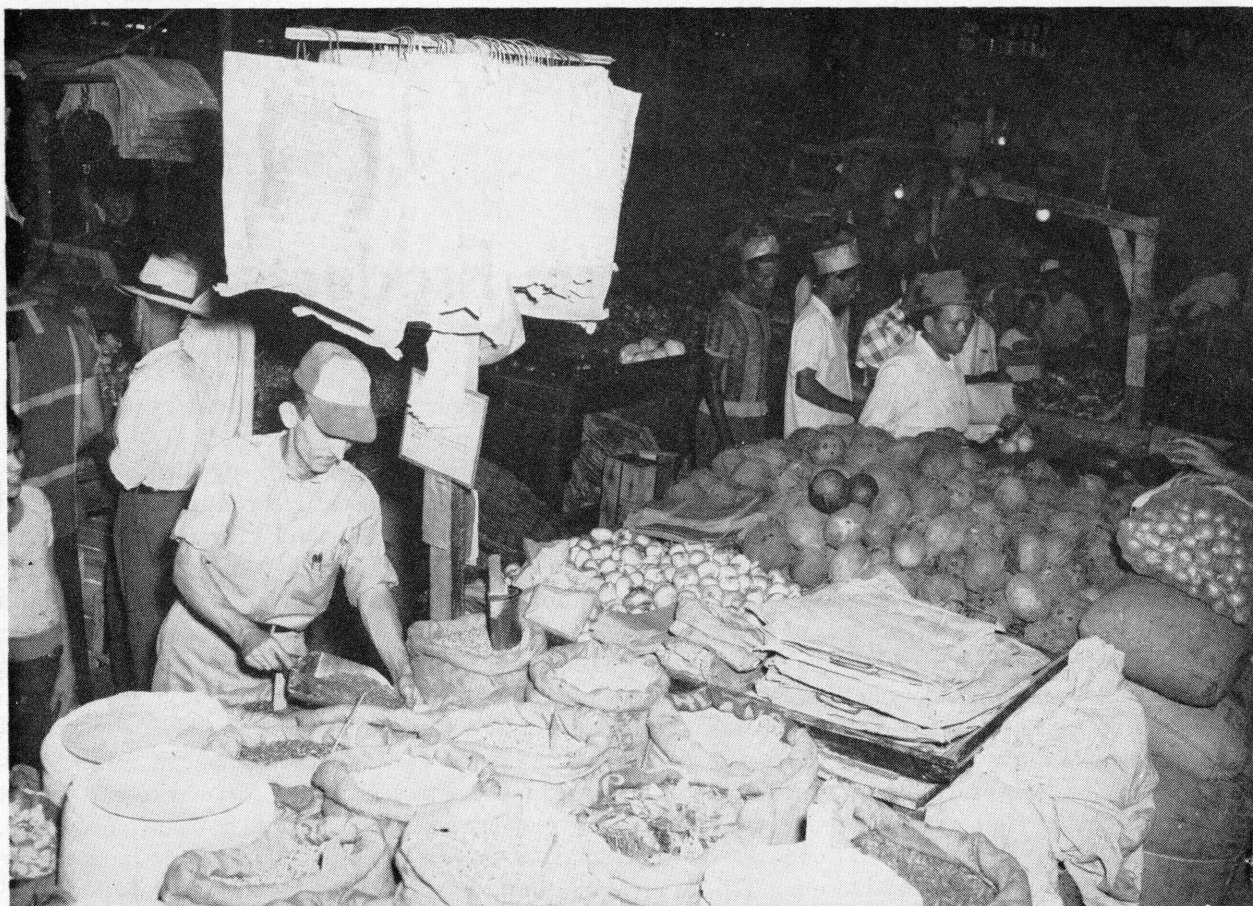
High markups are the rule in all channels of distribution. The retail food outlets are almost without number, and the sales volume of the big majority of them is small. Most of the retail food stores occupy less than 500 square feet of space, or under one-fifth of the space utilized by stores similarly classified on the mainland. Only 2 percent of the retail food stores exceed 1,000 square feet of space. The majority of the stores are ill-equipped. Most of them carry only a limited stock of staples, canned goods, and other grocery products. The few larger stores carry a complete line of groceries, some in combination with meats, dairy and poultry products, limited amounts of fresh produce, and a few frozen foods. Except for the advertising and promotion that is done in behalf of the national brands of food and related products shipped in from the mainland, there is very little merchandising or sales effort on the

part of larger retailers, and none by the smaller ones.

Retail food stores get their supplies from a number of sources. Locally produced agricultural products are bought mainly from truckers who buy from farmers, or they are obtained at the public market places. Some local processors and a very few farmers make direct sales to the stores. Imported foods and related items are bought from wholesalers and from brokers and distributive agents who perform the functions of wholesalers. Some of the wholesalers also sell at retail. Because of the way in which the marketing system developed and the deficiencies that have prevailed, manufacturers of national-brand products on the mainland have not undertaken to promote distribution on the island as they have in the States. Instead, most of them rely on brokers and wholesalers who have been given exclusive distributorships for the brand-name items. The majority of brokers and wholesalers in Puerto Rico enjoy such arrangements. This has been a major factor in limiting competition and maintaining high markups in the distribution of many products.

The marketing of agricultural products sold outside of Puerto Rico is left primarily to brokers, agents, and commission merchants. The big bulk of the sugar production is sold through brokers, as is the output of canned pineapple. Most of the fresh produce is sold through commission merchants. Except in the case of tobacco, there is very little direct selling to manufacturers or other distributors on the mainland.

During the period 1949 through 1951, the amount of money spent for food and related items averaged nearly 350 million dollars a year, or about 45 percent of the total consumption expendi-



The lack of orderly marketing in Puerto Rico has greatly influenced the pattern of agricultural production and the diets of the people of the island.

tures on the island. The value of imports was around 375 million dollars, about 30 percent of which represented the cost of imported food products alone. Total exports averaged around 235 million dollars, of which nearly 70 percent was represented by agricultural products, mostly sugar. Considering the dollar value of the internal and external trade, it is apparent that food and other agricultural products constitute a big percentage of the total. Any improvements that can be made in the marketing structure to increase efficiency and lower costs would therefore have a widespread beneficial effect on the economy of the island.

A properly functioning marketing system should act like a suction in drawing production off the farms into the various channels of use and consumption. By giving full expression to the demand that exists for the various products in the different outlets, such a marketing system

would provide the incentive for maximizing local production and afford the facilities required for complete utilization and orderly distribution of the total output. Instead, however, the many shortcomings that prevail have had the opposite effect. The limitations inherent in the present marketing system have not only narrowed the opportunities for farmers but also deprived consumers of large quantities of food and other agricultural commodities which could be produced locally.

The lack of an orderly marketing system for farm products has greatly influenced the pattern of agriculture. It has prevented desirable diversification and actually resulted in a level of production lower than that warranted by the available resources. Lands which should be planted to food and other crops for local use are not utilized to the best advantage. Farmers have had to plant, not the type of crops for which their

soils are best suited, but a crop such as sugarcane that could be marketed with some certainty of a return for the investment and labor expended.

The inadequacies of the present marketing system in Puerto Rico are so great that for crops other than sugarcane there is little incentive for farmers to make full use of modern production methods and improved practices. There is even fear of producing good crops because of the risk that these may not be absorbed by the limited market, thus forcing prices to low levels with losses to the producers. As a result, farmers are inclined to follow extensive production practices whereas virtually all farming should be on an intensive basis.

On the other hand, consumers in the towns and cities need the food and other products that could be produced but they cannot get them in sufficient volume. When local products are available, they usually are of low quality and in poor condition. This situation has forced consumers to prefer imported products for which they usually have to pay higher prices.

The vicious cycle shaped by the limitations of the antiquated marketing structure has operated for so long that it has come to be accepted as a normal condition to which the economy has had to adjust itself. As a result, farmers have been prone to discount or ignore the possibilities of the locally available outlets. The tendency is to produce without consideration for either the requirements of the market or the desires of the consumer. The farmers care very little about varieties and production techniques which affect the marketability of their products. When a crop is harvested, the portion to be sold is marketed without regard to grading or packing. The production moves to market as harvested, the good mixed with the inferior. There is no grading for the local market and no commercial standards have been set up which may be followed. Farm products reach the market in odd types of packages that are harmful to shipping and keeping qualities. Much of the production moves either in bulk or in bags. The indiscriminate packaging and handling that is employed slows down the buying and selling functions and prevents the development of buyer confidence in local products. All this is reflected in both the price paid by the buyer to the farmer and that charged to the consumer.

The movement of products from the farms to the marketing centers of Puerto Rico is a costly process. This is due to the inefficient methods that are employed. All the fruits and many other products that move in bulk to market are sold by count. Although some of the products are placed in sacks, their handling is as costly as handling bulk shipments. Since there is no grading to promote buyer confidence, the practice of the trade is to inspect each item that is received.

The characteristic bulk trucking of fruits results in much spoilage and waste since there is no protection against bruising or mashing. Oranges, grapefruit, and all other citrus, mangos, avocados, bananas, plantains, and other fruits are given no protection against heat while in transit. This improper handling and transporting reduces the keeping quality of the fruit to the extent that sales to merchants are reduced and supplies back up on farms in such a way as to constitute a theoretical surplus. Because storekeepers do not want to risk stocking up with fruit of poor keeping quality, stocks of fresh fruit in retail outlets usually are low and consumers are unable to satisfy their demand.

Practically all other food crops also suffer from improper handling and marketing practices. Leafy vegetables are seldom protected from rapid wilting and deterioration. Root crops, such as sweetpotatoes, taniars, and yams are sold just as they come out of the field. There is no washing, sorting, or grading to make them more attractive to the buyer. As a result, few retail stores handle any appreciable volume of the root crops. Instead, they prefer to handle imported substitutes such as Irish potatoes.

The ways in which farm products are produced, handled, and marketed satisfy neither the low- nor the high-income consumers. The low-income consumers cannot get a satisfactory second-grade product to meet their needs with the limited purchasing power available to them. On the other hand, the high-income consumers are unable to find the first-class products they can afford to buy. Only in the case of sugar is close attention paid to the requirements of the market and producers are compensated accordingly. This example could well serve as a landmark for improvements in the production and distribution of the many other agricultural products produced.



Improper handling of farm products results in spoilage and loss. Typical of the way in which produce is hauled from Puerto Rican farms is this loaded truck piled high with perishables which require protection from damage.

Producers of these other farm products tend to regard production and marketing as being widely separated functions. Their failure to understand the interdependence that prevails between the two stems largely from a lack of orientation and education. Ever since the early Spanish settlers first became engaged in farming, the focus of attention was on producing for export. As the agricultural industry developed, the farmer produced and turned his product over to a sugar mill, dealer, or other handler to perform the necessary preparatory services and marketing functions. In this way the farmer was kept separated from outside market contacts by the intermediaries who handled his sugar, tobacco, coffee, and other exportable products. Since the emphasis was on producing for export, practically no attention was given to meeting the needs of the local market, which became nothing more than a residual outlet. Whatever foodstuffs or other agricultural products

the farmers produced in excess of their own requirements were disposed of locally. Relatively little was produced primarily for local sale; and as the population increased, more and more foodstuffs had to be imported while other agricultural products were exported. This general situation still exists.

Under the circumstances that prevailed, farmers and others who had no direct hand in the disposition of agricultural products often looked upon marketing as an unproductive function. This is one reason why so little attention has been given to the development of the local marketing system. The products on the farm may be useful to the farmer or to those living in the vicinity, but they are useless to the people of the cities and other distant areas unless brought within their reach. Marketing is the connecting link between the farmer and the buyer. As such, it creates value. Through the marketing function other-

wise useless products of the farm are made available to the people of the towns and cities and thereby turned into useful commodities. The efficiency of the marketing system largely determines the ease with which the products flow from the farm to the consuming centers, the returns received by the producer, and the prices paid by the consumer. But even with the best marketing system, the farmer must gear production to the needs of the market and the preferences of the buyer in order to realize the greatest return from the investment and expended effort.

The farmer in Puerto Rico can no longer afford to overlook the potentialities of the local market. While taking full advantage of available export outlets, he should also realize that needs for foodstuffs and other farm products are so great as to offer many possibilities for more effective land use and a considerable increase in diversified production. An improved pattern of agricultural production and an efficient marketing system designed to meet the requirements of the *total* market—external and internal outlets—are basic to Puerto Rico's welfare. These should be focal points for orientation, education, and positive action.

There is little point in getting farmers to bring about a desired expansion in production unless the marketing system is capable of absorbing the output with some reasonable return that will pro-

vide an incentive for farmers to continue producing what is needed. Once the produce is ready to leave the farm, the marketing structure should at least offer the basic facilities necessary for processing and otherwise handling the output to the best advantage of both producers and consumers. While some such facilities are available in producing areas and in urban centers, they are mostly inadequate.

The most highly developed processing activities are to be found in the utilization of sugarcane for the production of raw and refined sugar and the utilization of molasses for the manufacture of rum. Next in order is the canning of pineapple. Except for some other scattered operations, processing of agricultural products and byproducts in Puerto Rico has received very little attention. Where processing takes place, as in pineapples, residues and wastes are not utilized. Most of the plants engaged in processing fruits and vegetables or slaughtering livestock and processing meats are small. They lack adequate facilities and technical help for efficient production.

Except for sugar and coffee, the bulk of the food commodities produced finds its way to the consumer through the municipal markets. These markets serve as concentration points for agricultural produce. Wholesaling and retailing functions, mostly performed by the same operators, are intermingled. Since the municipal markets bring together many people, other selling activities take place in them. The physical facilities provided are used mainly for retailing wearing apparel, and for food and beverage stands. As now operated these municipal markets serve neither the wholesaling nor the retailing functions effectively.

Smaller concentration points outside of towns are also used by the farmers. These points are not well defined, but usually they are located at a place along a road to which truckers and other middlemen go to buy the produce brought by the producer. The rule generally followed at these points by the buyers is to make the purchase from the farmer for as little as possible. And the producer seldom has any other alternative than to sell for whatever price is offered.

Products picked up at the roadside points are brought by the buyers to the municipal markets for resale at the best prices they can command. The lack of parking space, the absence of loading and unloading platforms, the multiple activities



The big bulk of Puerto Rico's food supply is distributed to consumers through a multitude of poorly stocked small stores, stands, and other small retail outlets.

performed that are not related to the marketing of agricultural products, and the crowded condition at these municipal markets result in confusion and prevent the free expression of the economic forces of supply and demand.

Such municipal markets as the ones located at Río Piedras, Santurce, Ponce, and Mayagüez operate with fairly large volumes of produce, but there is a tendency to glut them with commodities which most other markets may be lacking. None of the municipal markets has refrigerated facilities for perishables, and practically no private commercial cold-storage facilities are available near any of them.

Some Overall Marketing Needs

To develop the kind of marketing system needed to correct the conditions that now exist requires sound planning and action on many fronts. The forces of public and private leadership must be combined in a well directed and orientated program designed to promote understanding, encourage cooperation, and lead to the necessary solutions.

In recent years the Government of Puerto Rico has become increasingly aware of the need for improving the marketing system on the island. In 1949 the United States Department of Agriculture was requested to undertake a study of the marketing facilities and the distributive system of Puerto Rico, with special emphasis on the needs in the metropolitan area of San Juan, which is the principal port and also the main distribution center for imported and locally produced foodstuffs and other agricultural products.

The study, which was completed by the Production and Marketing Administration after more than a year's work in cooperation with agencies of the Puerto Rican Government, showed that improvements which could be made in marketing facilities in the San Juan area might result in the greatest benefit to the people of the island. The primary defects in the facilities at San Juan for handling food and related products were brought out as being: (1) The lack of sufficient warehouse facilities at shipside, (2) the splitting of market operations among several market areas, (3) excessive costs of cartage, deterioration, and spoilage, (4) the absence of a suitable livestock market with the necessary slaughtering and processing

facilities for the proper handling of animals, (5) the lack of grain storage, feed mixing, and milling facilities for the efficient handling of imported grain and utilization of the various commodities produced on the island that could be used in mixed feeds, and (6) the need for improved facilities for extracting vegetable oils.

To correct the defects that were found to exist, construction of a self-liquidating integrated central market was recommended. Such a market would include three types of facilities for the proper receiving, storing, handling, and selling of food and related products; for receiving and slaughtering animals and processing meats; and for receiving and storing grain, milling, mixing feed, and extracting vegetable oils. It was estimated that about 79 acres of land would be required for the construction of the three types of facilities and provide sufficient area for the expansion of each to meet future needs. The location would have to be near deep water along San Juan Bay to accommodate shipping lines. The main portion of the recommended project, which is the wholesale market, involves construction of facilities for shipping lines, including wharves and warehouses; stores or warehouses for all kinds of wholesale handlers of food; sheds for farmers and truckers; a retail market building; and space for public refrigerated and dry storage buildings, allied industries, a service station, and for future expansion.

Construction of the central market as recommended by this earlier study should be completed without delay, and the basic responsibility for this project obviously must rest with the Puerto Rican Department of Agriculture. At present all the food receiving and wholesaling operations are widely scattered in badly congested areas throughout the metropolitan area of San Juan. Existing facilities are wholly inadequate from every standpoint. The San Juan metropolitan area represents the hub of marketing and distribution in Puerto Rico. Unless improved facilities such as those already recommended as the result of intensive study are provided at this key center, there is little hope for increasing the efficiency and lowering the cost of food distribution on the island, or for attaining the market incentive that farmers need to produce more for local consumption. In the absence of the necessary improved marketing facilities, any talk about the need for farmers



This public market at Río Piedras serves a large segment of the population in the metropolitan area of San Juan, yet, like others on the island, it has neither the facilities nor the space for performing this function properly.

to increase their production to make more effective use of land resources and more nearly meet the requirements of the island's population becomes mere lip service.

As soon as the central market in the San Juan area is completed, steps should be taken to organize and improve marketing facilities in other parts of the island. This should include urban wholesale and retail centers, and establishment of

strategically located rural farm commodity concentration points with necessary grading and packing facilities so as to serve the interests of both producers and handlers and supplement urban market operations.

Private individuals and groups should be encouraged to participate in the improvement of existing establishments or the building of new facilities for food or other agricultural commodi-

ties. They should be stimulated to invest in improvements or construction that will modernize and increase the efficiency of such enterprises as retail outlets, processing plants, slaughterhouses and packing plants, and provide other facilities needed for properly utilizing agricultural products and byproducts.

Although a few outstanding cooperatives are engaged in the handling of such farm products as coffee, sugar, tobacco, and some others, there exists a wide-open opportunity for expanding such cooperative activity in the agriculture of the island. In 1950-51 there were 16 active agricultural cooperatives and their business volume was slightly more than 20 million dollars, mostly in marketing. Strengthening cooperative organizations and developing new cooperatives with able management to provide marketing and other services to farmers are urgent needs. But first, farmers must understand what is involved in a cooperative endeavor and what is expected from the individual member. This requires education for cooperative action and the development of sound leadership in local communities.

The agricultural agencies of the Puerto Rican Government should develop and agree on a well-rounded program that will help farmers improve the marketing of their products to gain the confidence of buyers and the preferences of consumers. Such a program should include educational work by the Extension Service to develop among farmers an understanding of the functions of an effective marketing system and the importance to them of catering to the wants of the market. Farmers in Puerto Rico need to be made aware of the production practices and methods which result in products that will satisfy the demand. This means planting the right varieties, using the proper techniques and methods of cultivation, harvesting at the right time, and marketing correctly in either fresh or processed forms as may be required.

A well-rounded program to help farmers improve their marketing should also provide for the establishment of grading and packing standards coupled with an intensive campaign to educate producers, middlemen, and consumers regarding the value of proper grading and packing. The cooperative grading and inspection agreements that already exist between the Puerto Rican and the Federal agricultural departments afford the

basis for such work. Grade and pack specifications are needed for additional fresh and processed agricultural products in Puerto Rico. Once these are established by the local Department of Agriculture, an adequate inspection service should be maintained to provide inspection whenever necessary or whenever it is requested by buyers or sellers of farm products. To this end Federal inspection for fresh and processed agricultural products, already existing for fruits and vegetables under the cooperative agreements, should always be available and expanded as conditions demand in order to provide a more complete service to producers and consumers.

In order to enable Puerto Rico to build and maintain a reputation for high quality products in outside markets, no fresh or processed fruits and vegetables should be permitted to be shipped from the island without the prior issuance of a Federal inspection certificate. This would be a protection as well as a help to both sellers and buyers. On the one hand, producers would be enabled to meet standard requirements which are generally understood by the receivers and put up a better quality pack by eliminating the possibility of mixing in poorer merchandise that would result in a discount or rejection. On the other hand, the receivers or buyers would be getting a more attractive and uniform product which they could utilize or resell with a greater degree of assurance and satisfaction. Moreover, an inspection certificate which certifies as to the quality and condition of the product is invaluable in the prosecution of claims for losses that may be filed against shipping companies or others.

The types of containers utilized for marketing agricultural products urgently need to be standardized in order to bring about proper packaging and help safeguard the quality and condition of the products from the time they are ready for market. The present use of a multiplicity of boxes and sacks and the extensive movement of fruits and other tender produce in bulk may at first glance appear to involve a low cost. Actually, however, such packaging and bulk handling represent false economy in view of the crushing and bruising that take place and the price discounts that result from these losses as well as from the unattractiveness of the products so marketed. The present practices are wasteful and costly both to producers and consumers. As an aid to cor-

recting this situation, consideration should be given to the enactment of a standard containers law which would prescribe the proper types of packaging materials to be used in marketing farm products both for local sale and outside shipment.

Other activities of the Puerto Rican Department of Agriculture need to be strengthened in order to stimulate the distribution and use of agricultural products and to make marketing more efficient. A change is needed in the tedious marketing practice of selling fruits and vegetables by count. The present system of counting bananas by fingers or spending hour after hour in counting a truck load of oranges or some other product results in a great waste of time and effort. It adds tremendously to the cost of marketing—a cost which must be borne by producers and consumers. The count system should be eliminated in favor of sales by weight and measure. Such a change coupled with the selling of farm products by grade would help producers get fair returns and assure buyers that they are getting full value for their money.

Moreover, the crop reporting and the market news services of the local Department of Agriculture should be extended in order to provide producers and buyers with more complete and timely information concerning production prospects, supplies available for and on markets, and prices paid at receiving centers both on and off the island. Work should be done with wholesalers and retailers in developing improved methods and practices of handling and merchandising perishable commodities so as to increase sales, reduce spoilage, and preserve freshness and quality for the consumer. In addition, this agency should develop marketing regulations and provide the necessary enforcement to promote the orderly handling and selling of farm commodities in local market centers and to safeguard both sellers and buyers from unscrupulous operators.

The marketing of agricultural products is heavily dependent on communication and transportation. Each plays a big part in governing the flow of information and the movement of supplies to and from the farms. The influence they exert in facilitating or hampering this interchange also has an effect on production, which in turn determines what is available for market. Both production and marketing in Puerto Rico long have

been adversely affected by the inadequacies of the local communication and transportation systems.

The absence of rural postal service and the existence of an obsolete telephone service are serious handicaps to the economy of Puerto Rico. The number of telephones available on the island is limited, only about 2½ percent, or less than 1,000 being in the rural areas. With the poor service that is rendered at high rates and the few telephones in the country sections, there is no practical way of rapidly reaching individual farmers to give them or obtain from them current information or to transact business. The telephone service operates with such a degree of inefficiency that it does not help in the marketing of products even after these have arrived in the market centers. It often takes an inordinately long time to complete a telephone call between San Juan and Río Piedras, two neighboring communities. Calls to other towns of the island, the farthest of which is less than 80 miles away, sometimes cannot be completed the same day.

Puerto Rico desperately needs a modern telephone service through which callers could dial to any place on the island at any time and without having to pay excessive rates. The possibility of improving the telephone service on the island, especially in the rural areas, through the telephone program administered by the Rural Electrification Administration of the United States Department of Agriculture certainly deserves to be explored by the Puerto Rican Government. This Federal agency is already assisting in the extension of electric power to rural communities on the island; perhaps something could be developed to provide the kind of telephone service that is so badly needed.

Transportation on the island is mostly by motor vehicle. The main highways along the coastal region are reasonably good, but other roads are so winding and steep that products hauled in trucks suffer considerable damage while in transit. While these roads in the interior are not adapted for use by modern heavy-type vehicles, they nevertheless have to be utilized because that is the only way agricultural products can be moved from the farms to the markets or processing plants, or to the wharves for outside shipment. This greatly increases the cost of transportation.

The poorest roads are throughout the upland and interior sections where most of the fruits,



Getting farm products to the nearest collection center or market over a road such as this is both time consuming and costly, yet many Puerto Rican farms in the upland areas have no other way out. This impedes production.

vegetables, and other food products are produced. Agriculture in many parts of the highland region is underdeveloped primarily because of the lack of necessary roads that would connect these areas with the main highways and permit hauling by motortruck.

If the agriculture of Puerto Rico is to be developed to its fullest potentialities, it is necessary to have a realistic road construction program that will enable the farmers to get out of the mountains and out of the mud. The planning of highways and road improvement should recognize the possibilities for developing production in the different agricultural areas that are not readily accessible or are poorly served by existing roads. While the responsibility for roads and highways rests with the Puerto Rican Department of Public Works, the advice of agricultural agency representatives should be sought in any planning that will affect agricultural areas. An advisory committee on rural road construction and improvement would insure proper coordination in planning and the wise expenditure of funds. Such a

committee should include representation from the Extension Service, the local Department of Agriculture, and other agencies responsible for providing services to rural communities.

Transportation to and from Puerto Rico, both by air and water, has improved considerably since the end of World War II. Ocean freight rates, however, tend to be rather high for the shipment of most commodities to and from the island. They are especially high for the movement of such farm products as perishables which, under ordinary circumstances, are unable to compete on mainland markets with similar products shipped in the same distances from other producing sections.

The whole question of freight rates to and from Puerto Rico should be closely and objectively studied. Such a study should include incoming rates for all products as well as the shipping cost differentials between agricultural products from Puerto Rico and those shipped from other producing areas to the same mainland markets. A comparative study between railroad freight rates in the United States and shipping charges in

Puerto Rico would give some indication of the advantages or disadvantages that farmers of the island have in supplying the southern and eastern markets on the mainland. The object of such a study should be to determine how shipping costs could be reduced, especially for those commodities which do not bear a proper freight-cost relationship. The study should also determine if the shipping companies serving Puerto Rico are providing the services and assuming the responsibilities commonly given and accepted in other areas with similar shipping charges. It is not always necessary to lower money charges for a service in order to reduce a marketing cost. Improvements in service also tend to lower the marketing expense if goods are delivered either faster or in an unimpaired condition.

Research, education, and technical training to develop skills are essential to the improvement of marketing and the utilization of agricultural products. A broad program of research and experimentation should be maintained under the leadership of the Experiment Station working in close cooperation with the different governmental agencies, private groups, farmers, handlers, processors, and others. This work should cover marketing and processing facilities, handling and processing techniques, product utilization and development of new uses, distribution and selling, and any other aspects of the marketing problem. The resulting information would provide the basis for education and for rendering technical assistance to farmers, processors, and distributors in the use of proper kinds of equipment, materials, management, and related services required for performing their respective functions efficiently and economically.

Vigorous action is needed to further the processing of Puerto Rican agricultural products and to improve the production of those now being produced. Except for the sugar mills and pineapple canning plants, very limited facilities exist for processing many of the products that could be processed. The few small plants available are for the most part poorly equipped and not organized for the efficient production of quality goods. The results of research are not readily taken up and put into commercial practice. Experience has indicated that under the conditions that prevail, research results in the processing field must first be tested and demonstrated to prove their prac-

tical application commercially. In order that research may be carried beyond the laboratory stage, it is necessary to conduct a pilot-plant operation. Such a plant is already being utilized by the Experiment Station in connection with the production of alcohol from molasses, especially in the manufacture of rum. Similarly, an agricultural processing pilot plant should be established and tied in with research on the marketing and utilization of farm products.

There is a marked distinction between a pilot plant and a plant that produces for the commercial market. A pilot plant is a small experimental facility designed for great flexibility of operation to develop all possible information on a proposed method or process of manufacture that laboratory investigations have shown to be promising for commercial exploitation. It is never built with the intention of marketing any product in large quantities for a profit as in a commercial plant. The pilot plant picks up where work in the laboratory ends.

Establishment of an agricultural processing pilot plant would provide the Puerto Rican Experiment Station with the kind of facility needed for developmental work in canning, freezing, dehydrating, or other processing that will not be carried out by private enterprise in its initial phases of high risk and losses. This work would include (1) developing methods for processing agricultural products to make them more useful or more appealing to the consumers and reduce losses, especially of perishables; (2) producing and marketing the processed products in small but sufficient quantities to test consumers' acceptance, determine possible market outlets and selling price, keeping qualities, type of container and label design needed, and to develop information on cost of production; (3) developing uses for agricultural byproducts and plant wastes; (4) cooperating with established agricultural industries in solving their technical problems; (5) cooperating with private groups and governmental agencies in establishing standards of identity and quality for fresh and processed agricultural products and assist in analytical work; and (6) cooperating with farmers, processors, and various governmental agencies in studies to determine the best-suited types and varieties of agricultural commodities for processing. After developmental work on a product is completed in the pilot plant, its commercial

exploitation should be left to the initiative of private enterprise.

Milk Marketing and Distribution

Dairying in Puerto Rico has gradually developed into one of the major enterprises and plays a very important part in the economy of the island. The production of milk accounts for more than 10 percent of the gross value of the agricultural output. The supply of milk produced, however, is far short of requirements. As a result there are substantial imports of milk in canned and other forms which, because of their relatively high price, are not consumed in the volume necessary to make up the deficit. These imports are equivalent to more than 60 percent of the milk supply produced on the island, an amount that approximates the volume of local milk sold for distribution.

Most of the advances in the production and distribution of milk have been made during the last decade. Improvements in distribution have, however, lagged behind developments on the production side. Only about one-fourth of the total amount of milk produced is handled by relatively modern marketing facilities. The remaining three-fourths is either consumed on the farm or distributed mainly by small producers directly to consumers under uncontrolled conditions. A large part of the milk distributed to consumers is unpasteurized.

Although sanitary regulations issued by the Puerto Rican Department of Health in 1934 govern the production, sale, and transportation of milk, the rapid growth of the dairy industry has made these regulations obsolete and, by the same token, a hindrance to the effective development of the industry in general. The regulations were drafted when most of the milk marketed was sold raw and moved directly from the farm to the consumer.

A dairy is defined by the sanitary regulations as any establishment, stable, or milking place where three or more cows are milked for the purpose of furnishing milk for public consumption. According to December 1951 figures from the Department of Health, there were operating under license 296 first-class dairies producing 148,000 quarts of milk per day, and 660 second-class dairies producing 66,000 quarts daily. The difference between a first- and second-class dairy is so small under the regulations that in most cases

they might as well all be placed in the same category. A first-class dairy is one that, among other things, has the necessary facilities to sterilize the containers, to cool the milk, to store it and to bottle it in accordance with the conditions required by the Secretary of Health. A dairy is designated as second-class when the Secretary of Health has exempted it from any of the requirements which in his opinion may not be absolutely necessary for the protection of public health.

During recent years there has been a tendency for some large producers to form commercial enterprises to process and distribute their own milk. At the end of 1951 there were four pasteurizing and distributing plants that were owned and operated by producers. In addition to utilizing milk from their own production, these producers bought milk from other farmers in order to have an adequate volume for their plants. The plants of these producer-distributors handled about 10 percent of the pasteurized milk sold in Puerto Rico. The remaining 90 percent was handled in pasteurizing plants of operators who bought all their milk from other producers.

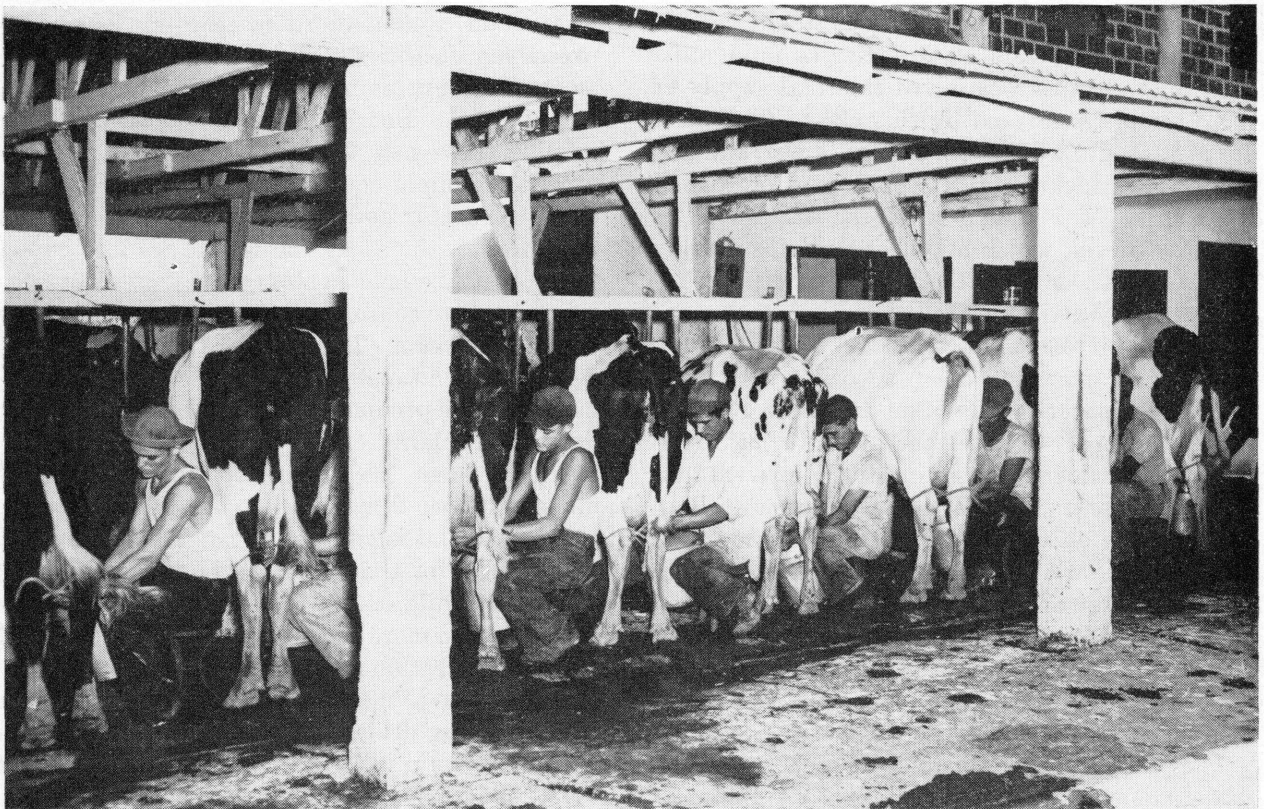
The December 1951 figures from the Department of Health show that pasteurizing plants processed about 138,000 quarts of milk per day. This volume came from the 296 licensed first-class dairies that produced a total of 148,000 quarts daily. These dairies produced the grade A milk that was delivered to plants for pasteurizing or for sale raw. It is estimated that in 1950-51, pasteurizing plants handled slightly more than 46 million quarts of milk, of which nearly 4 million quarts came from the herds of the plant operators and the remaining 42 million quarts were bought from dairy farmers. Of the total volume of milk received at the plants, nearly 35 million quarts were sold pasteurized. About 2 million quarts were sold as raw milk and about 5½ million quarts were sold in homogenized form. Nearly 2½ million quarts were converted to native cheese, and approximately 1 million quarts were involved in processing losses and spoilage.

In addition to the milk handled by the pasteurizing plants, there is a considerable volume marketed raw that does not move through these facilities. The Department of Health figures for December 1951 show 22 raw-milk bottling plants in operation and 402 grade D raw-milk dealers who handled about 50,000 quarts a day.

Considerably less than one-half of all the milk produced actually enters into the marketing system that is governed by the sanitary regulations of the Department of Health while an almost equal amount on a milk-equivalent basis is imported at great cost to more nearly meet consumer needs for milk. This indicates the existence of some serious deficiencies that are hampering the local dairy industry. At the same time there are several conditions which favor the development of a higher level of milk production. These are the relatively good prices paid to producers for market milk, the high volume of imports of milk products, and the potentiality of increasing per capita consumption from the present very low level. The favorable factors, however, are outweighed by the many weaknesses existing in the present marketing structure. Despite the progress that has been made during recent years, substantial improvements are still needed in the facilities for handling milk and in the methods of utilization and distribution. Marked changes are required in the method by which producers sell milk to dealers. A drastic revision is neces-

sary to modernize the sanitary regulations governing milk production, handling, and distribution.

As the milk-marketing system now functions in Puerto Rico, producers are unable to sell all the milk they produce. On the other hand, consumers are frequently unable to obtain all of the milk they may order from their supplier. This anomalous situation stems largely from the lack of a pricing system that would enable the dealers to absorb all the milk that a producer may deliver so as to assure a constantly adequate supply for the consuming public and complete utilization of the milk received from farmers. Milk is now sold by producers on the basis of a flat price per quart. Since this is a fluid milk price, dealers do not want to take on any more surplus milk than is absolutely necessary. Any surplus milk bought at the flat price results in a loss to the dealer if it is not marketed in fluid form. So the dealer tries to avoid this risk by having the producers deliver an even supply of milk that is predicated mostly on production during the season of lower output. During the flush season, which lasts from 4 to 6 weeks in April and May, milk has to be held back



Marketing and distribution play important roles in fixing the volume of milk production.

on most of the farms that supply dealers. Also, when fluid milk sales of an individual dealer drop off, producers may be required to make a corresponding cut in their deliveries.

A classified-price plan under which individual dealers would pay producers for milk according to the use made of the total supply handled by them should be substituted for the present flat-price system. Such a pricing method would enable the dealers to pay producers a fluid milk price for all milk sold in fluid form and to utilize surplus milk in other ways at a price that would permit the sale of the resulting dairy product without any loss to them. With a classified-price plan in effect, dealers would be able to absorb all the milk delivered to them while producers would be assured of a ready outlet for all their production throughout the year. Being certain of an adequate supply of milk, dealers would be in a position to promote consumption and encourage increased sales of locally produced milk in order to make the best use of the supply available. This would benefit producers and consumers as well as the milk dealers.

Prices for only two classes of milk would have to be established in Puerto Rico. The class 1 price would be the highest, and it would include all milk used or sold by a dealer as fluid milk. By far the biggest portion of the total supply of milk would be covered by this class. The price for class 2 milk would be somewhat lower, and this class would include all milk not used or sold as fluid milk. This would cover the disposition of any excess milk which might be used for making cream, cheese, or any other dairy product.

From a practical standpoint, the amount of excess or surplus milk available is very small. The normal operation of an adequately supplied fluid milk market requires an excess of 10 to 15 percent in order to meet the daily variations in sales to consumers. Even under the present system of marketing, it is doubtful whether such an excess exists on the island's markets except that it may be available over a short period during the flush season of production. In the flush season surplus milk does become a problem. It is during this period that a classified-price plan would be especially helpful in milk marketing, and beneficial through the rest of the year.

If a classified-price plan is to work, the milk dealers must know how to utilize any supplies of milk in excess of their fluid-sales requirements.

They also must have the equipment necessary for handling any surplus milk. Most of the milk dealers in Puerto Rico have neither. These dealers need to learn how to use surplus milk in making cream, cottage cheese, and other high-quality dairy products that will be readily acceptable to consumers. The leading use currently made of surplus milk is in the manufacture of a pressed white cheese, commonly known as "queso del país," which is of poor holding quality. A very small quantity of milk is made into a chocolate drink.

There is an excellent opportunity for educational work among milk dealers in improving the handling and utilization of the entire milk supply. The Extension Service and the Puerto Rican Department of Agriculture should get together in meeting this need by the employment of a qualified specialist to work with the milk dealers as well as with the producers.

Puerto Rico probably never will be able to produce enough milk to meet the milk consumption requirements of its increasing population. In view of this, the greatest emphasis possible should be given to the use of milk for fluid consumption. The island cannot afford to maintain expensive processing facilities to take care of the limited amount of surplus milk that might be available at any time. But in order to utilize whatever surplus there may be, dealers should have the necessary simple equipment, principally a good cream separator and a cheese vat. Surplus milk run through the separator would produce cream which could be held in storage or frozen for subsequent sale to consumers, restaurants, or used for making ice cream. The skim milk could be utilized for making chocolate milk drink, cultured buttermilk, and for producing cottage cheese. The production of quality cream and the other products would broaden the outlet for locally produced milk and meet demands that are not now being satisfied. The island could not advantageously utilize milk for the manufacture of butter, or of evaporated milk or any similar product that may be brought in more economically from specialized producing areas on the mainland.

In addition to instituting a classified-price plan and educating dealers to achieve the best utilization of the total milk supply, improvements need to be made in some of the other aspects of milk marketing. For example, at present milk is sold

by producers to dealers at so much per quart without regard to the butterfat content. This overlooks the fact that butterfat has value and also adds to the quality of the milk. Since butterfat costs money to produce, farmers are entitled to be paid for any amounts in excess of a fixed standard. By the same token, deductions should be made when the butterfat content of milk delivered by a producer falls below what is required. The establishment of differentials for butterfat would provide producers with an incentive to produce higher quality milk, and the dealers would be paying for the kind of milk delivered. Dealers receiving milk from producers would have to weigh and sample the daily deliveries from producers and test the samples for butterfat content so as to pay farmers on the basis of both the volume of and the butterfat in the milk received.

Farmers need to be sure that they are getting the full return from the milk they deliver. At the same time, from a competitive standpoint, individual dealers need to be certain that the cost of milk used for a specific purpose is the same for all of them. Meeting these requirements, which are essential to stability in a milk market and to protect the interests of consumers, calls for some mechanism that will operate in establishing producer prices and provide the means by which the weights, tests, and the utilization of milk received by dealers may be verified. This could be supplied in simple form by the issuance of a Federal order regulating the handling of milk. The dairy industry in Puerto Rico, especially the producers, should give serious consideration to the possibility of such assistance from the United States Department of Agriculture under the Agricultural Marketing Agreement Act of 1937. Federal orders regulating the handling of milk are playing an important role in improving marketing conditions in a large number of fluid milk markets on the mainland. The application of this mechanism to meet the needs in Puerto Rico deserves thorough exploration for the many advantages it may have to offer toward establishing there an orderly system of milk marketing.

Any efforts that producers and dealers may make to improve the marketing and utilization of milk necessarily must rest on a foundation of consumer confidence in the supply. Properly drafted and enforced sanitary regulations are not only a

protection to consumers but they also are helpful to milk producers and dealers in maintaining the quality of their product. In order to meet the requirements of the dairy industry as it is developing in Puerto Rico, the Department of Health might well promulgate new and modernized sanitary regulations to govern the production, processing, distribution and other handling of milk and milk products for public consumption. The Puerto Rican Department of Agriculture and other agricultural agencies could then participate in the development of sanitary regulations that would meet the practical needs of the island's dairy industry and operate to promote consumer confidence in the local milk supply. At the same time, steps should be taken to develop an adequate staff of well-trained personnel to provide the inspection, laboratory testing, and enforcement necessary for the successful administration of such regulations.

Marketing Livestock and Meats

Most of the meat consumed in Puerto Rico comes from local production. Some imports are made to supplement this supply. Consumers are accustomed to and prefer the native beef. The output of this meat is derived mainly from the slaughter of dairy and dual-purpose cattle. Hogs and some goats and sheep are also produced for slaughter.

A survey made by the Puerto Rican Government in 1950 showed that in the previous year about 90,000 head of cattle were slaughtered, about 73,000 in public abattoirs and the remainder on farms and in private abattoirs. About 230,000 pigs are farrowed annually, of which it is estimated that 80 percent are eventually slaughtered on farms and at roadside restaurants and used for "roast pig." Most of the rest, the mature and heavy hogs, are butchered in the abattoirs. About 50,000 goats are slaughtered in a year, nearly 90 percent of them on farms and the remaining 10 percent in abattoirs. The few sheep and lambs produced are butchered mainly on the farms.

Farmers with meat animals for sale may dispose of them to an independent buyer, who usually owns a truck, or the producer may bring or drive them to one of the market places where all kinds of buyers may be found. Some of the smaller animals such as pigs, goats, and calves may be sold to individuals for slaughter for family use. In some sections private lots are maintained for the



The demand for poultry and eggs is good in Puerto Rico, but the generally poor way in which these locally produced products are marketed is costly to both the producer and the consumer.

sale of larger meat animals and dairy stock, with the operator charging a small fee for each animal sold.

The livestock markets available to producers provide rather limited outlets for the animals farmers have to sell. There are no large buyers mainly because of the lack of adequate facilities for slaughtering livestock and handling the meat produced. Many persons, including farmers, prefer to do their own slaughtering. The large number of hogs, many cattle, and most of the other animals slaughtered by farmers and other individuals are butchered with no other facilities than a table, knives, and some pails of water. Meat

from these animals is sold in the neighborhood without the inspection needed to safeguard public health.

In towns and cities slaughtering is done in municipal abattoirs, although a few slaughterhouses are privately owned. Most abattoirs lack facilities for properly killing, bleeding, cutting the animals, and for handling the edible meat and disposing of the inedible parts and waste materials. Most slaughterhouse operations are performed by untrained personnel and the methods employed are antiquated and wasteful. In most places the abattoirs serve small communities with insufficient demand to make the slaughtering of full-grown ani-

mals profitable. This forces the slaughter of many undeveloped animals while still in their most economical period of growth. Since no cooling or chilling facilities are available in the public as well as in most of the private abattoirs, daily slaughtering is necessary to provide consumers with fresh meat.

Under the present system of slaughtering, practically no byproducts, with the exception of hides, are utilized. Rendering facilities are not available at public abattoirs. Pork fat is either left on the hog or sold at very low prices. Fat often constitutes part of the wastes. Native cattle, calves, and goats have very little edible fat to be trimmed. There is, however, considerable wastage of inedible fat, bone, and flesh that could be salvaged, if facilities were available, and used for livestock feed and other purposes. One great waste is in hides. Most hides of animals slaughtered by farmers and others outside of slaughterhouses are completely wasted. At the abattoirs, hides are improperly removed from the slaughtered animals and poorly cleaned and cured. This greatly reduces the quality of the hides and sharply lowers the price.

Because of the lack of facilities for utilizing slaughterhouse byproducts, few processed meat products are produced. As a result, Puerto Ricans have to depend upon imports of these foods, which come chiefly from the mainland. The seasoning of these imported products, however, does not meet the taste of consumers on the island. Consequently, improved central facilities for marketing and slaughtering livestock and for handling and processing meats and byproducts would fill a great need in Puerto Rico.

The necessary improvements could be achieved economically by establishing modern facilities and not by rebuilding the old and inefficient ones that now exist. Methods of marketing livestock need to be drastically changed to enable farmers to benefit fully from the demand for meat and to encourage them to bring their animals to heavier weights. The possibility of establishing a livestock auction market for the exclusive use of farmers in selling animals should be studied along with other necessary improvements. An inspection program for live animals and meat and meat products is also needed, but this cannot function until more adequate slaughtering facilities are available. The grading of meat produced at

slaughterhouses is likewise essential. Establishment of official grades would give the consumers greater confidence in meat buying. At present consumers are forced to accept meat arbitrarily classified by retailers, and this classification is not uniform among the sellers.

At least one modern facility for receiving and slaughtering animals and processing meats should be established as soon as possible. Such a plant should be an integral part of the central market proposed to be built near deep water in the San Juan area. From this location the plant could easily serve the requirements of a large part of the island's population. Additional facilities for slaughtering livestock and handling meats could later be established in other sections, probably at Mayagüez and Ponce, as experience may indicate. However, to insure the successful operation of any such facilities, it is necessary to have them manned by adequately trained personnel in order to serve the best interests of livestock producers and meat consumers.

Marketing Sugarcane

In the economic structure of Puerto Rico, the production and milling of sugarcane holds a dominant position. Since 1949, the amount of sugarcane ground at mills, or *centrals*, has averaged more than 10,500,000 tons annually. This amount of cane in 1951 came from the harvest of 366,404 acres on 16,525 farms. The sugarcane was processed in 34 mills and produced slightly under 1 $\frac{1}{4}$ million tons of 96° sugar. In addition, more than 60 $\frac{1}{4}$ million gallons of blackstrap molasses were obtained from the processing operations which are carried on quite efficiently in most of the mills. Also in 1951, the production of refined sugar amounted to 207,815 tons from 7 refineries.

Like all other domestic areas producing sugar, Puerto Rico is affected by the Sugar Act which governs the production and marketing of raw and refined sugar. Puerto Rico's quota for marketing on the mainland has been fixed at 910,000 tons of sugar, raw value, by action of Congress in 1948. An amendment to the Sugar Act in 1951 increased this raw-sugar quota to 1,080,000 tons a year for the period from January 1, 1953, to December 31, 1956. Out of the total amount of raw sugar, Puerto Rico is permitted to market on the mainland under the quota, marketings of "direct-con-

sumption sugar," which is principally refined sugar, are limited by the Sugar Act at not to exceed 126,033 short tons, raw value. In addition, the Sugar Act requires that a quota be established for the amounts of sugar which may be marketed for local consumption. This has generally been set at from 100,000 to 110,000 tons.

Although marketing is far more advanced in the sugar industry than it is in the other segments of Puerto Rican agriculture, there are a number of practices and problems that deserve careful attention. Studies completed in 1950 by the Sugar Branch of the Production and Marketing Administration, United States Department of Agriculture, and in 1951 by the Puerto Rican Experiment Station, show that certain practices and methods in the movement of sugarcane from farms to mills could be changed to increase marketing efficiency with material benefits to both the producers and the mill operators. The hauling of sugarcane from farms to the *centrals* is costly because of such practices as excessive long hauls and cross-hauls of cane, and extra transportation and other allowances paid by mill operators in order to attract to their plants a greater volume of cane for grinding. These and other practices that add to the cost of marketing should be reduced to a minimum compatible with a situation in which growers have an efficient mill to grind their cane and the *centrals* have a sufficient volume of cane for capacity operation.

In the process of transporting sugarcane from the fields to the *centrals*, growers suffer losses through improper hauling and the use of inadequate transporting and handling equipment. Considerable time is lost in the delivery of cane at most mills through the use of too many trucks in relation to the tonnage of cane to be hauled, the lack of proper equipment and facilities for weighing and unloading, and the lack of organization in timing the harvesting and delivery of cane by growers. This costly waste could be substantially reduced, as has been done by some mills, by the installation of two sets of scales, one for weighing loaded trucks and the other for weighing the empties. Also, the installation of tilting devices operated by hydraulic pressure would make possible the dumping of cane directly from the trucks and thereby speed up unloading.

When gluts occur, the *centrals* are unable to handle the cane as delivered and they have to pile

it up in the open until grinding can start. The delays and the storage cause deterioration and losses. These result in lowered returns to producers since payments by the sugar *centrals* are based on tests of sucrose content at the time of processing and not at the time the sugarcane arrives at the mill. Use of improved equipment to speed unloading of cane, more efficient use of trucks for the tonnage to be hauled, and the assignment of deliveries by growers more nearly in relation to the capacity of the *centrals* would greatly relieve congestion and gluts at these mills and result in substantial savings to sugarcane producers as well as to the mills.

The marketing of sugarcane has been regulated in Puerto Rico since the local Legislature in 1942 enacted Act No. 221 declaring the sugar mills to be public service enterprises. Responsibility for administering this law was vested in the Public Service Commission of Puerto Rico. In 1951, the Legislature enacted Act No. 426 which provided for the regulation of the marketing of sugarcane, including prices paid to producers, and established the Sugar Board of Puerto Rico to administer its provisions. The new law repealed Act No. 221 and became effective May 13, 1951. The provisions of Act No. 426 are of such scope as to enable the Sugar Board through proper administration to encourage and bring about many improvements needed in the marketing of sugarcane to increase efficiency in the movement of cane from the farms to the mills, reduce the costs of handling the cane, and assist growers in maximizing their returns from sugarcane marketings.

Since the Sugar Board is essentially a regulatory body, it cannot function effectively without sufficient properly trained personnel required for inspection, enforcement, and other activities. It must also be able to support an adequate and continuous research program that will keep abreast of developments and needs in the marketing of cane and provide the basic information required for intelligent corrective actions. At the same time, there should be effective coordination between operations under the Puerto Rican Sugar Act and the Federal Sugar Act. In many ways the local law can supplement the Federal legislation.

Although Puerto Rico's raw-sugar marketing quota has been increased from time to time by congressional action since Federal sugar legislation



A bottleneck is the unloading of sugarcane at the mills.

was first enacted in 1934, the island's mainland marketing quota for "direct-consumption" sugar has remained frozen at 126,033 short tons, raw value. This quota was established on the basis of the "best year" of the 1931-33 period. At the level of "sugar consumption" then established by the Secretary of Agriculture under the Sugar Act of 1934, mainland seaboard refiners had meltings of 4,182,000 short tons, raw value, for the initial quota year. Since the first controls over sugar marketings went into effect, the volume of sugar refined by mainland refineries has followed a steady upward trend, rising by more than 1 million tons since 1934 to 5,436,000 tons in 1951.

A study of the history of the sugar legislation clearly shows that from the beginning it was not the intention of the Federal Government that the refining limitations should become permanent, despite the mainland refiners' claim for such protection. At the urgent request of the President when the 1934 legislation was pending before Congress, a compromise was achieved under which the "direct-consumption" quotas were to expire on

March 1, 1940, ten months prior to the expiration of the act as a whole. Then again, in signing the Sugar Act of 1937, the President expressed the hope that the next session of the Congress would consider repealing the clause which continued the refining restriction to March 1, 1940, or shortening the period.

When the time came for renewing the Sugar Act in 1940, the war in Europe blotted out virtually all problems other than defense needs. Nevertheless, in considering renewal legislation the House Agriculture Committee, in accord with the position taken by the Department of Agriculture, rejected an amendment to reinstate the limitations on Hawaiian and Puerto Rican "direct-consumption" sugar after they had expired on March 1, 1940. However, the restrictions were subsequently reinserted on the floor of the House and remained in the bill which was enacted on October 15, 1940.

Conditions which arose during the period of World War II made it impossible to engage in any major legislative controversy on the subject

of limitations on refined sugar. Sugar became short and quotas under the Sugar Act were suspended by Presidential proclamation for the duration of the emergency. The executive branch of the Federal Government, however, continued its opposition to the refined-sugar limitations. This was indicated in the favorable report on a 2-year extension of the Sugar Act made by the War Food Administration during the middle of 1944. This report said:

The Administration's views on certain desirable changes in the sugar quota provisions of the act have been repeatedly stated to the committee on former occasions and need not be repeated at this time. However, since current uncertainties preclude satisfactory consideration of amendments to the act at this time and the quota provisions have been in suspense since April 13, 1942, under presidential proclamation, enactment of H. R. 4833 without amendment is recommended. * * *

The next time sugar legislation came up for consideration by the Congress was in 1948. The question of refining restrictions was not raised by the Department of Agriculture before the congressional committees. The bill that was enacted as the Sugar Act of 1948 continued the limitations on refining that previously had been in effect.

In 1951, when the Congress considered legislation (H. R. 4521) that would amend the Sugar Act of 1948 to provide for an increase in Puerto Rico's raw-sugar marketing quota, among other changes, the Resident Commissioner of Puerto Rico raised before the House Committee on Agriculture the issue of restrictions on the refining of sugar in Puerto Rico. In its report recommending passage of the bill, the House Committee on Agriculture stated:

The committee was asked to consider an increase in the amount of refined sugar which can be shipped to the mainland from Puerto Rico as part of its quota. At the present time, Puerto Rico is limited to shipment of 126,000 tons of refined sugar to the mainland. It refines, of course, that sugar which is used domestically, but the total of approximately 236,000 tons which is now refined in Puerto Rico, is only about one-half the refining capacity presently available on the island. Puerto Rico's quota of refined sugar has not been increased since the establishment of sugar quotas in 1934, and no change is made in the refined-sugar quotas in this bill. The committee feels that some adjustment might well be considered in the proportion of the Puerto Rico quota which can be refined on the island, but it felt that this question is a matter distinctly separate from the assignment of overall production quotas, with which this bill is concerned, and it believes that this matter should be taken up separately and at another time.

After H. R. 4521 was passed by the House, it was referred in the Senate to the Committee on Finance. In its report recommending passage of the bill, the Senate Committee on Finance said:

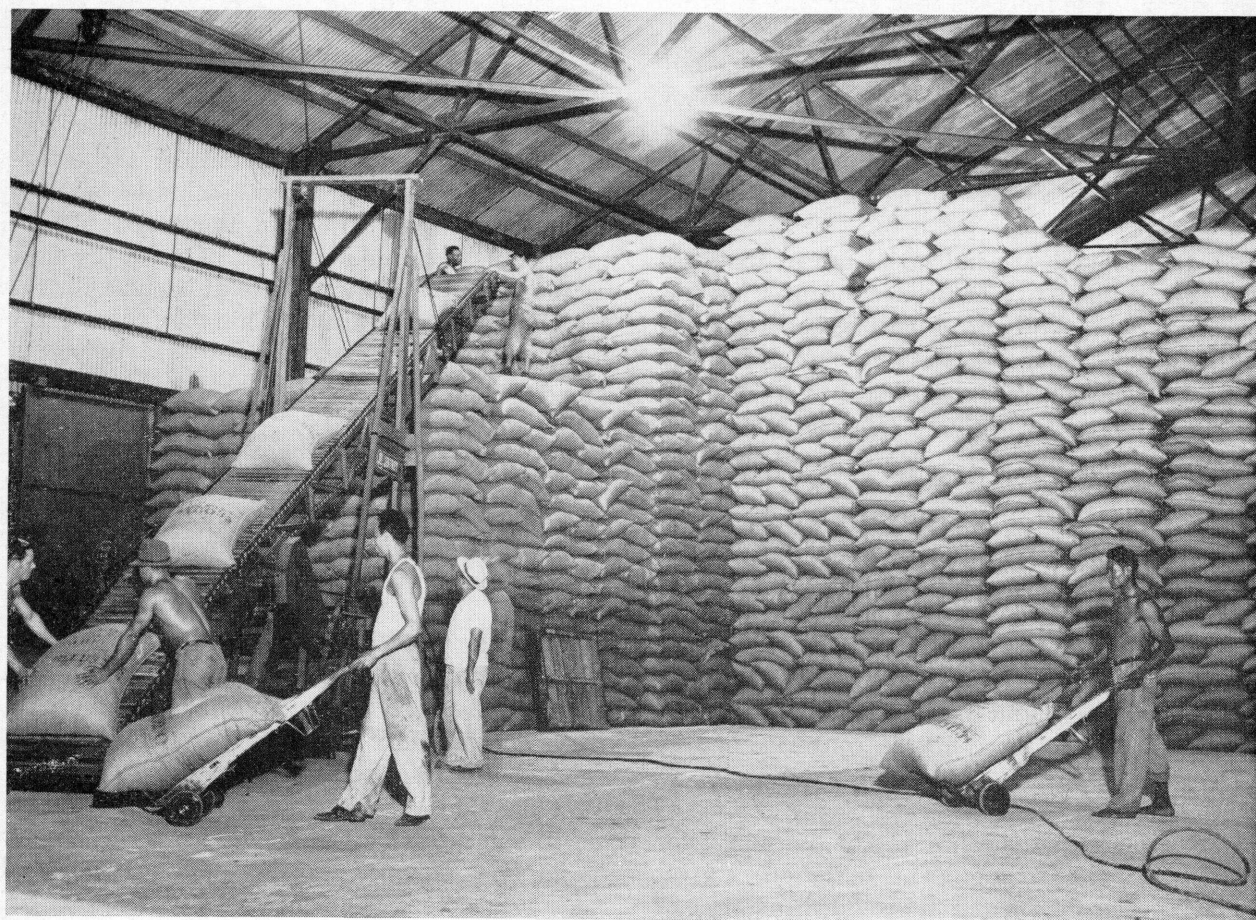
With reference to the question of increasing the amount of refined sugar which can be shipped to the mainland from Puerto Rico as part of its quota, the committee feels that quotas on refined or direct-consumption sugar are part of the comprehensive philosophy of the Sugar Act of 1948, which places restrictions on every segment of the domestic industry, and should not be considered separately. The quotas for each unit of the domestic industry are so interrelated in the production and distribution of both raw and refined sugar that a change in one would require a reconsideration of all. The committee agrees generally with the statement made before the committee by the representatives of the domestic sugar industry "that the fabric of the law is one piece, that it makes a complete and indivisible whole, and that, because of the interdependence of its provisions and certain results, a single subject, such as for example the size of an insular refined quota, cannot be divided for separate consideration." However ample protection is afforded all areas in that the duration of the proposed legislation is only for 4 years.

Thus the issue of restrictions on refining sugar in Puerto Rico still remains unsettled. Since the limitations have been imposed by congressional action, only the Congress can modify or eliminate them. In view of the legislative history of the refined-sugar quota for Puerto Rico, the Congress might find it desirable to reexamine this question on its merits in the light of conditions which have changed materially since 1934, when the existing restrictions were first put into effect. From the standpoint of Puerto Rico and the great need for improving its economy, it is important to note that any increase in the amount of sugar refined on the island adds to the value of the product of each acre devoted to the cultivation of sugarcane. However, in view of the refining facilities already available on the mainland and the great cost of establishing modern plants, it is extremely doubtful whether Puerto Rico logically could, even without refined-sugar quota restrictions, economically refine more sugar than the capacity of existing facilities would permit. In any event, the fact remains that the amount of sugar now permitted to be refined is only about one-half the refining capacity available on the island. The remaining plant capacity represents a luxury which the economy of Puerto Rico can ill afford to maintain in imposed idleness. An increase of 225,000 or 250,000 tons in the shipment quota would pave the way

for putting these facilities to work. It would greatly supplement the self-help efforts being made to deal with the serious economic problems through the development of industry and the improvement of agriculture. Certainly, as the House Committee on Agriculture has already said, "some adjustment might well be considered in the proportion of the Puerto Rico quota which can be refined on the island."

Since about 80 percent of the sugar produced in Puerto Rico is marketed as raw sugar, the cost of marketing this product has a great and very direct influence on the payments made to producers for the cane that is ground at the mills. Most of the raw sugar is shipped in jute bags which come mainly from India. The cost of a jute bag just before the outbreak of fighting in Korea was about 55 cents each, but this soon increased to 70 cents and more per bag. The expenditure for jute bags amounted to about 4 million dollars in the year before the Korean fighting.

Bulk shipments of raw sugar offer an alternative to shipping in bags. This method appears to hold excellent possibilities for lowering marketing costs and for reducing the large amount of money that now leaves the island for the purchase of jute bags. One Puerto Rican *central* recently started making bulk shipments, and this may be followed by others in the future. There is, however, the question of the investments required in establishing the facilities and providing the equipment for handling bulk shipments and the benefits that would be returned to the mills and the growers. In the long run, any savings made by increasing efficiency in marketing should be shared by all segments of the industry. While the actual cost of marketing raw sugar by improved methods should determine the selling and delivery expense deductions made from the price paid growers for their cane, recognition must be given to the necessity of providing sufficient incentive for the capital investment required to



Sacks of raw sugar being stored in a sugar mill warehouse to await shipment to the United States mainland.

make bulk shipments possible. Thus it is apparent that all who share in the savings brought about by the establishment of such improved facilities most share proportionately the costs of depreciation and interest charges that may be necessary to provide the investment incentive.

While sugar is the principal product derived from sugarcane, there are important byproducts of considerable value if effectively utilized. So far, molasses is the most versatile of all the byproducts of sugarcane processing. It is the raw material from which numerous products of relatively high market value are prepared. These include rum, ethyl alcohol, organic acids, and others. Full utilization of all molasses produced in Puerto Rico should be one of the principal goals in view of the large volume of this byproduct that results from the processing of sugarcane. In 1951, for example, the output of molasses totaled 60,300,000 gallons, each ton of cane processed yielding 5.74 gallons of molasses in addition to 233.8 pounds of raw sugar. The molasses that year was sold for an average gross price of slightly more than 21 cents per gallon. This price, of course, reflected the increased demand for molasses for alcohol production due to the fighting in Korea. Under normal conditions in the past, molasses has sold for a much lower price—often only a few cents per gallon.

In Puerto Rico the industrial use of molasses has been limited to the production of rum and alcohol. Some experimental work is being done on the utilization of molasses in the production of yeast for cattle feed and human protein supplement. Work is also being done on the production of organic acids and esters derived from molasses. In its recently constructed pilot plant, the Experiment Station is studying the problems of utilizing molasses for the production of rum and alcohol, and for the manufacture of cordials, gin, and other similar products. Research and development work on the utilization of molasses needs to be continued and intensified in order that economical ways and means may be found by which this raw material may be converted and its value increased.

In recent years a sharply increasing volume of molasses has been shipped to the mainland for use in livestock feeding. This outlet offers great opportunities for expansion provided the price of molasses is in a favorable relationship to corn on

an equivalent feeding-value basis. Usually the price of molasses has been cheaper than the relative value of corn as a feed, except in time of defense or of war when molasses has been required for the manufacture of large quantities of industrial alcohol. Recent developments in the production of alcohol from petroleum products are cutting into the potential future market for molasses as a source of alcohol. This highlights the need for intensive efforts to expand the utilization of molasses in other fields. Increasing the use of molasses in livestock feeding would provide a vast and steady outlet for this product. At present, the sugar industry in Puerto Rico lacks any organization that would enable it to develop and promote market outlets for molasses and improvements in the handling and selling of this product. An industry-wide approach to the problem of marketing molasses produced in Puerto Rico is very much needed.

Another important byproduct from sugarcane is bagasse. Most of the bagasse produced on the island is either wasted or burned for fuel to produce power for operating the sugar mills, with some excess electric power being sold for other purposes. The utilization of bagasse has received much attention on the mainland for the manufacture of several products including pressed board, paper and cardboard liner, and for the production of phenolic plastics. One of the more recent developments is the use of bagasse for the production of newsprint. This particular usage has many possibilities, and it could become a major outlet for bagasse. The possibility and feasibility of establishing industries in Puerto Rico that would utilize bagasse should be given careful consideration. The large supply of bagasse that is available each year on the island warrants a considerable amount of research and developmental work on the utilization of this byproduct.

Marketing Pineapples

Most of the pineapples produced in Puerto Rico are marketed on the mainland in fresh and processed forms. The volume of production, however, is relatively small despite the definite advantages the island has for producing this fruit on a much broader scale. From a marketing standpoint, Puerto Rico is strategically located since it is so close to the big consuming centers of the eastern half of the United States mainland.

A considerable amount of land is adapted to growing pineapples, but production practices need to be improved materially to increase yields. During 1951 Puerto Rico harvested only a little more than 3,000 acres of pineapples, which yielded 27,700 tons of fruit. This represented a decline from the previous year when nearly 3,900 acres were grown with a production in excess of 35,000 tons of pineapples.

Puerto Rico usually supplies about 20 percent of the fresh pineapples sold on the mainland. On the other hand, the volume of processed or prepared pineapple represents only about 3 percent or less of the mainland trade in these items, which totals from 85 million to 100 million dollars a year. Puerto Rico could profitably supply far greater portions of the outlets for both fresh and processed pineapples. But in order to do this, production would have to be increased and the industry would have to be organized to improve its marketing structure.

With the limited production now available, the best fruit moves to the fresh market and any that cannot be sold in fresh form becomes available for processing. When prices for fresh pineapples are high, the amount of fruit that goes into the processing plants is small. Thus the processing plants are used largely as a secondary outlet and there always is great uncertainty as to the volume of the output from these facilities. A considerable amount of effort has been made to develop outlets on the mainland for processed pineapple, both the fruit and the juice, from Puerto Rico. A steadily increasing demand exists. But much of the effort made to build a market for the island's pineapple products will be lost if the supply needed to meet the demand is not available. The pineapple industry on the island must face the fact that if it is going to produce for both the fresh and the processed markets it must increase pineapple acreage and production.

Under the system of marketing both fresh and processed pineapples that has developed, neither the growers nor the processors have very much voice over the selling of their products. The fresh pineapples shipped to the mainland are almost entirely sold through sales representatives on the New York auction market. The processed pineapple is sold through brokers, most of the output being handled by a single broker. The big part of the pack is put up under private labels

of the various buyers. While sales representatives and brokers have a definite place in marketing, the producers and processors of pineapples in Puerto Rico cannot afford to leave the selling job entirely to them. Those engaged in growing and processing pineapples in Puerto Rico need to become more thoroughly familiar with the markets for which they are producing and with the buyers of their fresh and processed products. They need to explore and develop more adequate selling arrangements to establish closer working relationships with their buyers and broaden their market outlets.

The selling of Puerto Rican processed pineapple in the mainland markets has been greatly aided by the institution of Federal inspection beginning with the 1951 crop. The first step was to introduce sanitary practices in processing the fruit and to encourage the adoption of improved production methods. Plants were cleaned up, and modernized. Modern equipment was installed. As a result, most of the pineapple processed in Puerto Rico is packed under good sanitary practices and the products have been gaining in acceptability on the markets. It is interesting to note that since these very substantial improvements have been made, the mainland baby-food industry has been buying much of its canned pineapple from Puerto Rican processing plants operating under Federal inspection.

With the growing of more pineapples and effective industrywide organization for marketing the fruit, Puerto Rico would be well on the way toward becoming a significant factor in the pineapple business. The present facilities for marketing and processing are, however, inadequate for handling a very substantial increase in pineapple production. Of the few processing plants on the island, only two are of any appreciable size. The operators of these plants are also pineapple growers. When the harvest season is at its peak they naturally want to take care of their own pineapples first. This leaves other growers who do not have processing facilities available to them without a processing outlet at a time when their fruit may have no other market. Thus pineapple growers who do not own facilities risk the possibility of not being able to dispose of their fruit when it may be at the peak of quality for processing. If the fresh market is low at the same time they may not be able to sell it at all. This is one

of the situations that has tended to hold down the growing of pineapples.

Improved organization in marketing and more adequate facilities for processing would give growers greater assurance of market outlets and encourage them to produce more pineapples. Farmers would then be in position to produce pineapples to be harvested exclusively for the processing plants and brought to the processors in the most ideal stage of maturity, rather than as a byproduct of the fresh fruit market.

If a processor is to produce high-quality products, it is necessary to start out with good fruit. In order to encourage growers to produce and deliver quality fruit for processing, the differences in quality need to be recognized in the price that is paid the producers. Purchases of pineapples

by all processing plants should be made on the basis of official grade and quality standards so that the plant operators may pay and the growers receive full value for the kind of fruit delivered. Such official standards for pineapples sold for processing should be established and inspection provided by the Puerto Rican Department of Agriculture.

The general situation that prevails in the pineapple industry of Puerto Rico indicates the probable need for establishing a cooperative organization that would handle and market the fruit for growers. Such a marketing cooperative could handle pineapples both for fresh market and for processing so as to provide assured outlets for all the fruit produced by its grower members. By making its own marketing arrangements with dis-



Inside a pineapple canning plant in Puerto Rico. Practically all of the canned pineapple products produced on the island are sold in markets of the United States mainland.

tributors and buyers on the mainland and supplying quality fruit properly graded and packed to meet market needs and preferences, such a cooperative would be in a strong position to realize for Puerto Rico the full potential of the demand for fresh pineapples. The cooperative could have its own processing facilities, but this would not be necessary if other adequate facilities were available. If the cooperative did not have its own plant for processing, it could enter into contracts to supply pineapples to plants owned by others. Through a system of pooling returns from all sales, both for fresh market and for processing, the cooperative would make it possible for all its grower members to share fairly in the total market for pineapples. Producers should be paid on the basis of the grade and quality of fruit delivered by them in order to provide the incentive needed to encourage good production.

There is also need for establishing an overall organization that would be concerned with the problems of all segments of the pineapple industry. Such an organization, which could be designated as the Pineapple Institute of Puerto Rico, should be built on a strong foundation of industry-wide support and financed by growers, processors, and others engaged in the industry. The institute would need to be staffed with a few competent people who understand the problems of producing, processing, and marketing pineapples. Of importance also would be the maintenance of close working relationships with the Department of Agriculture, the Experiment Station, Extension Service, and other governmental agencies as well as with various commercial organizations and private groups both on the island and on the mainland. A properly administered institute of this character could be of inestimable value to the pineapple industry of Puerto Rico. Working with the appropriate agencies, it could be the motivating force that would spearhead many important projects in the fields of education and information for growers and processors; research in production, processing, and marketing; technical assistance and quality control; and market promotion and publicity to encourage more extensive distribution and increased consumption of fresh and processed pineapples from Puerto Rico. By providing a focal point such as the institute would afford, the pineapple industry of Puerto Rico

would be in position to formulate a definite program for developing production and marketing and enlist cooperation from many governmental and private sources to help carry out such a program effectively with a minimum cost to all directly concerned.

While pineapple production is being increased and markets expanded, the possibilities of the locally available outlets should not be overlooked. There is need for improving the selling of fresh and processed pineapples from local sources. Retail outlets are usually unable to obtain selected fruit of the quality and pack used for outside shipment. Puerto Rican pineapple processors have virtually ignored the local sales possibilities, with the result that products from distant competitive areas have gained the preference of consumers. With proper selling, adequate distribution, and merchandising of locally produced fresh and processed pineapples of good quality, Puerto Rican growers and processors could substantially increase their sales on the island.

An additional source of revenue could be provided by the utilization of the byproducts from the pineapple-processing plants. These byproducts are now wasted for the most part. One of the major uses to which they could be put is in the manufacture of feed, as has been done with citrus pulp in Florida. The pineapple industry of Puerto Rico each year loses a considerable amount of money by not utilizing the waste from its processing plants. If the necessary facilities for processing this material were established, it could be turned into valuable livestock feed for local sale.

Tobacco Marketing

Most of the tobacco produced in Puerto Rico is shipped to the mainland where it is used in the manufacture of cigars. In earlier years, the big bulk of the tobacco grown there was manufactured locally into cigars which were sold mainly in the continental United States markets. The peak of these shipments was reached in 1919 when the value of cigars sold in all outside outlets exceeded 11½ million dollars. This was followed by a very sharp decline which continued through the years since the end of World War I when cigar consumption gave way to an increase in the use of cigarettes. The value of manufactured tobacco shipped from the island in recent years has been rather insignificant.

The shift from local processing to shipments of unmanufactured tobacco placed Puerto Rico in the position of having to depend almost exclusively on the demand for filler tobacco among cigar manufacturers on the mainland. With the disappearance of the large cigar manufacturers from the island, the number of tobacco buyers was reduced. Most of the tobacco produced came to be handled by a few large purchasers who also were able to extend production credit to the big number of small growers engaged in producing this crop.

The production of tobacco in Puerto Rico has in recent years been regulated by the Department of Agriculture under a local law which provides for a quota system intended to prevent violent changes in production and prices by restricting or promoting output in keeping with supply and demand requirements for Puerto Rican filler tobacco. While individual producers are assigned poundage production quotas, there is no assurance that the amount of the quota will be produced although so far the total produced has been adequate. Any farmer who wishes to do so is permitted to sell to or buy from another producer an assigned quota. This traffic in quotas makes it possible for a grower to produce and sell more tobacco than his own quota would provide. It also enables farmers to get into the growing of tobacco even though their land may be unsuited for the production of this crop. Moreover, the possibility of being able to sell an assigned quota maintains a larger number of small quotas than otherwise would be the case, since a relatively large number of the small quotas are sold year after year to larger growers.

From the standpoint of lending greater stability to tobacco production, the sale of quotas should be prohibited if a practicable means of preventing such sale could be devised. The quota should be assigned, not to the individual, but to the land and then only to land that is suitable for growing tobacco. However, in view of the rugged terrain, the general inaccessibility of many farms, the considerable uncertainty of being able to get correct acreage reports, along with some other factors, it appears that poundage quotas are peculiarly suited to Puerto Rico, more so than acreage allotments. A small reserve could be retained from the total production quota for any year to take care of the needs of new producers and other con-

tingencies. The tobacco quota should be so administered as to encourage high yields per acre coupled with good use of land resources.

The emphasis should be on producing high-quality tobacco as this is the kind that the market demands and for which the buyers are willing to pay the best prices. While quality is determined and influenced by many factors, it necessarily must start with the crop itself. The finished product can be no better than the quality of the tobacco leaf as harvested on the farm. There is some variation in the tobacco that is produced in different parts of the island. While part of this may be due to differences in the kinds of soil on which the tobacco may be grown, much of it is attributable to the varieties and strains of tobacco planted and the fertilization and cultivation practices that are followed in producing the crop as well as curing practices. More extensive research and experimental work are needed to develop improved varieties and strains best adapted to the different producing sections and to reduce the number now being planted to bring about greater uniformity in the desirable characteristics of the tobacco grown. Studies should also be made of the tobacco fertilizing and cultivating practices to develop improvements that will result in lower costs and higher yields of good quality leaf. This should include research on the role of minor and trace elements in tobacco growing on the island.

In tobacco, as with most other crops, the Puerto Rican farmer has paid very little attention to the techniques of marketing. Quality in tobacco depends, to a great extent, on the processes of drying and fermentation, and on preventing damage to the leaf during those processes. Most farmers do not have the proper facilities for drying and curing their tobacco. The methods employed are the same as those that have been in use for many generations. Because of the lack of facilities and the poor methods of handling the tobacco, severe losses are suffered by growers whenever adverse weather conditions prevail during the curing process. Such losses could be greatly reduced by having curing sheds so constructed and equipped as to permit some control over temperature and humidity. Research and experimental work should be conducted to improve methods of curing tobacco and to develop practical types of sheds or barns to be used under the conditions that prevail on the island.

Once the requirements for the construction of proper curing facilities are established and improved curing methods formulated, it should be possible to demonstrate to growers the benefits to be derived from them. Individual small producers, of course, could not afford to build improved curing facilities. However, they could be helped by cooperative action in establishing facilities that would cure their tobacco properly. The existing cooperatives should take the leadership in such a movement.

After the tobacco is ready to be sold, Puerto Rican growers usually find themselves at a disadvantage in marketing. The large number of small producers have to deal with a relatively few buyers. The growers lack the information that the buyers have on marketing conditions and relative values of different qualities of tobacco. As a result, the sellers are in a poor bargaining position. The present system lends itself to practices against which growers have little protection. This situation gives rise to distrust of the buyers and complaints and criticisms among the growers.

The bargaining position of growers in the marketing of tobacco could be strengthened materially by a wider use of grades for Puerto Rican tobacco and by the establishment of a market news service predicated on price quotations of graded tobacco. This would enable farmers to sell and buyers to purchase tobacco more nearly according to the value of any particular lot.

In recent years the Tobacco Branch of the Production and Marketing Administration has developed tentative grades for Puerto Rican tobacco. This work should be intensified with the help of the local Department of Agriculture and other agencies. The cooperation of all segments of the industry on the island and the trade on the mainland should be enlisted in the perfection and utilization of grades and of grade inspection services. The development of grades which can be applied to tobacco at the time of delivery by the farmer represents an essential step in the improvement of tobacco marketing. After such grades are formulated and put into effect, their use in all deliveries of tobacco by growers to buyers should be made mandatory. Before this could be done, however, it would be necessary to develop among all growers and buyers a full understanding of the grading and inspection system and the pur-



Puerto Rican tobacco is piled for fermentation in warehouses such as this one at Cayey. A number of the tobacco handling practices have continued unchanged for generations.

pose to be served by the adoption of grade standards.

What happens to the tobacco after it is delivered by the producer plays a part in determining the price that is paid the grower. Many costs begin to pile up after the tobacco is received at the warehouses, where further handling and processing of the leaf takes place before shipment to manufacturers. Improvements in the physical handling of tobacco through the warehouses need to be developed to increase efficiency and reduce costs as well as to improve the quality of the tobacco by better care and fermentation. There is also need for developing improved methods of stripping tobacco to reduce the costs of this operation.

Since Puerto Rican tobacco is characterized by its excellent burning qualities and mild aroma, it has become highly desirable in cigar manufacturing. Improvements in the production, curing, grading, and handling of the island's output of tobacco are essential in building and maintaining a good sales position and keeping abreast of any changes in market requirements.

Positive efforts need to be made to merchandise and promote the use of Puerto Rican tobacco.

Producers and their marketing organizations cannot afford to wait until buyers come knocking at their doors. Aggressive selling of the crop by satisfying the needs of regular buyers and winning new customers for good-quality tobacco meeting official grade standards will build up demand and increase returns to the growers. The grading of tobacco and the establishment of defi-

nite and realistic pricing policies would help provide the basis upon which Puerto Rican tobacco could be merchandised with confidence and offered for sale to buyers generally. At the same time, cost-reduction practices should be employed wherever possible in the production and handling of tobacco to enable the industry to compete successfully with other areas.

Chapter XII

Land and Tax Policies

Puerto Rico's problem of too many people on too little land is in reality a problem of too little production from so many people. This is clearly recognized in the Puerto Rican Government's recently launched program to encourage industrial development by various means, including investment incentives. It is only partially recognized, and often overlooked, in many other governmental policies which directly or indirectly concern agriculture.

Although the physical area of Puerto Rico cannot be stretched to increase the number of acres, there are ways of achieving for the people the best utilization of the land that is available so as to maximize production and distribution for the greatest good to the economy. Governmental powers of regulation, acquisition, and taxation are generally regarded as potent influences that can help or hinder desirable social and economic developments. The exercise of these powers in dealing with problems of the land and in providing incentives to encourage increased production and improvements in the flow of products from the farms is nothing new to agriculture on the mainland. It is, however, relatively new to the agriculture of Puerto Rico.

With such a large and rapidly growing population pressing harder and harder against a very limited area of land, Puerto Rico is right up against the necessity of increasing total production in order to survive. And if any improvement is to be made in the generally low standard of living that now prevails, the per capita output of goods and services must also be increased. This situation virtually prescribes the course that governmental policies and practices will have to take. In the case of agriculture, it calls for close scrutiny of every policy and practice to make sure that

progress in attaining the desirable objectives is helped and not hindered. Any handicaps that exist must be eliminated wherever possible by positive measures that will encourage agricultural development and greater output with proper land use. In all of this, the fundamental aspects of land tenure and taxation become of paramount importance because of the major role these two factors play in determining social and economic patterns in rural areas.

The Shaping of a Land Policy

For more than a half century, since Puerto Rico first came under the American flag, the problem of land tenure on the island has been of public concern. During the congressional debates which led to the enactment of the First Organic Act (Foraker Act, approved April 12, 1900) for the establishment of a civil government in Puerto Rico, foresighted members of Congress expressed the fear that the limited area of land on the island would soon become monopolized by big investors who would be attracted to produce sugar and other crops which, under the change in sovereignty, could enter the United States markets tariff-free. This fear was heightened by what had already taken place the year before, in 1899, when a devastating hurricane hit the island with consequent loss of crops and the depreciation and mortgaging of farm lands. Through a separate joint resolution which was approved May 1, 1900, Congress sought to prevent the development of an agrarian monopoly which would own and control the best lands of the island. This resolution said:

No corporation shall be authorized to conduct the business of buying and selling real estate or be permitted to hold or own real estate except such as may be reasonably necessary to enable it to carry out the purposes for which

it was created, and every corporation hereafter authorized to engage in agriculture shall by its charter be restricted to the ownership and control of not to exceed five hundred acres of land; and this provision shall be held to prevent any member of a corporation engaged in agriculture from being in any wise interested in any other corporation engaged in agriculture. Corporations, however, may loan funds upon real estate security, and purchase real estate when necessary for collection of loans, but they shall dispose of real estate so obtained within five years after receiving the title. Corporations not organized in Puerto Rico, and doing business therein, shall be bound by the provisions of this section so far as they are applicable.

This action by Congress was the first step toward the establishment of a land policy for Puerto Rico. But consolidation of landholdings had already begun, and the Puerto Rican Government's authority to enforce this federally imposed restriction against corporations came into question. In the Second Organic Act (the Jones Act, approved March 2, 1917), Congress specifically ratified the 500-acre limitation on corporation holdings in Puerto Rico, despite the efforts that were made to revise it. But this did not solve the Puerto Rican Government's enforcement difficulties. The contention was that only the Federal authority could be employed to enforce the limitation.

It was not until March 25, 1940, that the issue was settled by a decision of the Supreme Court of the United States which upheld the right of the Puerto Rican Government to carry out the 500-acre restriction against corporation landholdings in Puerto Rico which Congress had provided. In its decision the Supreme Court declared:

Surely nothing more immediately touches the local concern of Puerto Rico than legislation giving effect to the congressional restriction on corporate landholdings. This policy was born of the special needs of a congested population largely dependent upon the land for its livelihood. It was enunciated as soon as Congress became responsible for the welfare of the island's people, was retained against vigorous attempts to modify it, and was reaffirmed when Congress enlarged Puerto Rico's powers of self-government. Surely Congress meant its action to have significance beyond mere empty words.

Meanwhile, other developments had taken place on the island in the effort to deal with the land-tenure problem. In 1921 the Puerto Rican Legislature enacted the Homestead Commission Act which provided for the "creation of farms to be leased to farm laborers and to grant them title thereto." It also authorized "the construction of houses for artisans and laborers with funds of the

People of Puerto Rico." Out of this legislation came an unplanned program that was largely concerned with land distribution as a good thing in itself.

Land acquired for distribution was purchased from private owners without full consideration of the usefulness of the land for agricultural purposes. Most of the land bought was located in the mountainous region of the island. The low productivity of the soil, the ruggedness of the topography of the land, and the inaccessibility of most of the subsistence homesteads that were established greatly hindered the success of the program. It was, nevertheless, a significant start in land-tenure reform on the island. The families of those farm laborers who were fortunate enough to get a farm of average productivity were able to improve their standards of living.

Between 1921 and 1942, a total of 2,241 subsistence homesteads were created out of about 24,000 acres of land. The most common size of the farms was 16 acres, and each farmer had 20 years in which to pay for his farm to obtain title. Because of the nature of the soils and other physical characteristics of the farms, most of these proved too small to operate as economic units. As a result, the homesteaders had to become part-time farmers and work off their farms as day laborers during a large part of the year.

An additional attempt to tackle the land-tenure problem in Puerto Rico was made, beginning in 1935, by the Puerto Rico Reconstruction Administration, a Federal agency created to help develop the economy of the island and improve the condition of its people. Included in the plans of this agency was the establishment of 10,339 subsistence farms, mostly in the upland coffee, fruit, and tobacco producing areas. Up to the end of June 1943, this agency had actually established 8,457 subsistence units of 1 to 3 acres; 1,062 subsistence units of about 1 acre each; 608 small individual-family farms ranging from 4 to 20 acres in size; and resettled 212 "squatters" on quarter-acre plots. In addition to providing small plots, the Puerto Rico Reconstruction Administration built dwellings for a large number of families covered by its program. The agency provided 7,093 dwellings at a cost slightly in excess of \$7,100,000. Families living in them pay a small rental for the house and the land. Many of the families signed purchase agreements to pay for the properties in

monthly installments over a period of 10 to 25 years.

The most ambitious part of the land-tenure program of the Puerto Rico Reconstruction Administration, and also one that has had a continuing influence, was the Administration's attempt to work out a solution to the problem of concentrated landholdings as presented by the big estates and absentee ownership in the areas producing sugarcane. As a first step in this direction, the agency acquired in 1936 the sugar mill *Central Lafayette* and 10,000 acres of land. This property was owned by an absentee French family. After the purchase, the best lands of this estate were divided into 12 units, supposedly organized as cooperatives. After a poor performance which

lasted 3 years, the lands were sold to individual farmers in plots ranging from 11 to 140 acres. The sugar mill, however, continues to operate successfully as a cooperative.

In 1939 the Puerto Rico Reconstruction Administration helped finance the purchase of another sugar mill, *Central Los Caños*, which included 5,466 acres of sugarcane lands. This property was purchased by a small group of farmers and the mill was organized as a cooperative. Since then, this cooperative has grown into one of the leading farm organizations on the island.

The land-tenure problem in Puerto Rico received the attention of still another Federal agency beginning in 1937. This was the Farm Security Administration, which in 1946 was ab-



A block of sugarcane land, located near Camuy, that was subdivided into family-type farms and purchased with the help of farm ownership loans made by the Farmers Home Administration. The homes of two borrowers are shown in the distance.

sorbed by the establishment of the Farmers Home Administration. The program now being carried out by the Farmers Home Administration represents the most consistent and positive attempt of the Federal Government to influence land tenure on the island. It encourages the acquisition, development, and operation of family-type farms by providing supervised credit to eligible farmers who are unable to obtain the necessary credit from other sources on reasonable terms. Up to the middle of 1951, nearly 800 small farmers had been helped to purchase an equal number of family-type farms with loans totaling slightly more than 4 million dollars. This phase of the Farmers Home Administration's program has been carried out mostly through acquiring large farms, about 175 of them, and subdividing them into family-type farms.

As a whole, the farm ownership program of the Farmers Home Administration has been very successful in Puerto Rico, and it has had a significant impact among the families that have been helped as well as on their production. This may be attributed in large part to the agency's well-organized and supervised credit activities. Striking improvements in land use have been brought about under this program by the subdivision of large farms into family-type units. An economic study of four of these subdivided large farms located in an area where sugarcane was the principal crop indicates the kind of progress that can be made by the proper establishment of family-type farms. Although the total area in sugarcane was maintained at about 4,000 acres, the production of food crops was increased from 119 acres to more than 1,700 acres under the change in land tenure. Moreover, these farmers were keeping in excess of 2,700 animal units where before there were none. And to maintain these animals, the pastures had been greatly improved.

The Land Law of Puerto Rico

After the Supreme Court of the United States had by its decision in 1940 established the right of the Puerto Rican Government to enforce the 500-acre limitation on corporate landholdings in Puerto Rico, local action was taken to carry out the policy which Congress had first enunciated in 1900. As a step in this direction, the local Legislature enacted the Land Law of Puerto Rico

(Act No. 26, approved April 12, 1941) which prescribed various measures for dealing with the land-tenure problem on the island. It created the Land Authority of Puerto Rico as the administrative agency and granted broad powers under which it could operate. In the statement of motives which is written into the act, the Legislature outlined the underlying social and economic philosophy in part as follows:

The Legislature of Puerto Rico, by the present declaration and through the instrumentality of this act, states that the land in Puerto Rico is to be considered as a source of life, dignity, and economic freedom for the men and women who till it, and it is declared that it is the policy of The People of Puerto Rico that finally each person who tills the land shall be the owner of that land which supports him. * * *

It is a fundamental purpose of this act to put an end to corporative latifundia and to every large concentration of land in the hands of entities legally organized in such wise as to tend to perpetuate themselves and to prevent for all time the division of the great landed estates; and it is likewise the purpose to prevent the reappearance of such latifundia in the future. To win these objectives it is absolutely necessary, as a fundamental agrarian policy of The People of Puerto Rico, to extend the limitation on land holdings, set at five hundred acres, to every organization or partnership of a corporative character, to the end of preventing that through other juridical instrumentalities the purpose sought by this legislation be frustrated.

This fundamental public policy would not be complete if it were not accompanied by, as a corollary germane to its nature and scope (sic) of the purpose of providing that in the case of land where, for natural or economic reasons, the division of the land is not advisable from a standpoint of efficiency, the greatest diffusion possible of the economic benefits of the land may still be effected, thereby contributing to raise substantially the standard of living of the greatest possible number of families. It is with a view to this phase of the legislative purpose that it is considered indispensable to make provision for the creation of proportional-profit farms through which the diffusion of the wealth may be effected. It is also an integral part of the moral purpose and aims of dignity and economic freedom embodied in the public policy of the Legislature, to furnish the means whereby the social class of *agregados*, or, that is, of agricultural laborers enslaved (sic) through the fact that they are not the owners of even the lot where they have their homes, will disappear from Puerto Rico; and to that end the Legislature states the fundamental human right of all human beings who live exclusively by the tilling of the soil, to be the owners of at least a piece of that land which they may use to erect thereon, in the full enjoyment of the inviolability guaranteed by law for the homestead of the citizen, their own homes, thereby delivering them from coercion and leaving them free to sell their labor through fair and equitable bargaining.

Thus through the medium of the Land Law, the local Legislature sought to establish for Puerto Rico a definite land policy. While this was based on the objective of carrying out the 500-acre limitation on corporate holdings prescribed earlier by Congress, it also introduced some land-tenure innovations such as the proportional-profit farm. The Land Law authorizes four types of programs for improving the system of land tenure. These provide for (1) the establishment of proportional-profit farms, (2) resettlement of *agregados*, farm laborers or squatters, in organized rural communities; (3) assistance in the creation of family-type farms; and (4) education to encourage and develop group action and improve community living. In addition there is authority for the industrial processing of agricultural products, and the conservation and development of land resources such as by drainage and irrigation.

Originally, the Land Authority was responsible for administering all of the programs under the Land Law. To carry out the *agregado* resettlement and family-type farm programs, there was created in the Land Authority a Social Programs Administration which also was given the responsibility for the educational activities among the participating farm people and the workers on proportional-profit farms. A reorganization plan put into effect in 1950 transferred the Social Programs Administration and its functions from the Land Authority to the Puerto Rican Department of Agriculture. At the same time the Executive Director of the Land Authority was made responsible to the Commissioner of Agriculture (now the Secretary of Agriculture) for the proper administration of that agency with its major activity being the proportional-profit farm program.

The program for the resettlement of *agregados* is authorized by Title V of the Land Law, which since 1948 has been administered by the Social Programs Administration now in the insular Department of Agriculture. It provides for the establishment of rural communities in which every *agregado* who can qualify may hold a plot of land on which to build a home and produce some food for family subsistence. Plots of from about one-fourth *cuerda* to three *cuerdas* (a *cuerda* equals 0.9712 acre) are made available in usufruct to these landless farm workers who are mostly employed in the sugarcane fields. Parcels are supplied with-

out charge. The distribution of the plots is made generally through drawings.

Up to the middle of June 1951, approximately 25,000 families of *agregados* had been resettled in 181 rural communities established under this program. Altogether, there are about 73,000 such families still to be taken care of by resettlement. The plan is to resettle 2,000 families a year at an annual cost of around \$200,000 for the purchase and subdivision of the necessary land. The communities in which the *agregados* are resettled have from 100 to 500 families. The design of these communities provides for the establishment of such services and facilities as schools, churches, health centers, parks, consumer cooperatives, community pastures, water supply, and electricity. In the various communities a program of education is carried out by the Social Programs Administration to encourage and develop cooperation and direct group action. Experience with this so-called "community action plan" has shown that mutual aid and self-help thrive best where an integrated community life exists.

The family-type farm program is authorized by Title VI of the Land Law. Under this program, the Social Programs Administration acquires large parcels of agricultural lands, usually those not under cultivation, and divides them into small farms which are sold to eligible applicants. Current legislation requires that each farm must be not less than 5.5 *cuerdas* in size and the cost of the land must not be more than \$5,000. Although anyone may apply for one of these farms, selections are made on the basis of farming experience and other qualifications likely to contribute to successful operation of the farm. The number of applications is far in excess of the number of farms. During the 6-year period to the middle of June 1951, only 437 family-type farms with a total of 6,283 acres had been established throughout the island, mostly in the highland areas. The cost of the land and the improvements was around \$450,000. The cost of the farms is financed with a small initial down payment and the remainder in installments over a 40-year period. The Social Programs Administration also carries out some educational work among these small farmers, especially to encourage self-help and cooperative action and to assist with production, marketing, and farm management problems.

The program for establishing proportional-profit farms is authorized by Title IV of the Land Law. These farms generally constitute large land-holdings that were privately operated by corporate or other owners but which have been acquired by the Land Authority. Parcels of from 100 to 500 acres, or more if necessary, are operated through management contracts by qualified farmers or other persons selected by the Land Authority to serve as managers. In taking charge of a farm, the manager is required to manage it for the benefit of each and every worker employed on that place. Under the terms of the management contract, the manager represents his own interest as well as the interest of all the laborers working on the farm, not in the relationship of employer and employee, but as partners in the enterprise. The Land Authority's concern in organizing any parcel of a given acreage as a farm is, in its own words, "to put the land to its most appropriate use, for the benefit of the entire community, achieving, at the same time, a more equitable distribution of the income yielded by the cultivation of the land, fostering the highest possible degree of production, and offering the workers the greatest employment opportunities. The achievement of that goal shall yield a large income to the great majority of our population, which will in turn result in increased welfare for the entire community. The function of the Authority is limited to the creation of the farm and to its supervision, both its agricultural and economic operations, under the provisions of the Land Law of Puerto Rico."

The main crop on the proportional-profit farms is sugarcane. The Land Authority also operates two sugar mills, *Central Cambalache* and *Central Plazuela*, which grind cane from farms in their respective areas. In the operation of the sugarcane lands on the proportional-profit farms, officials and employees of the Land Authority are responsible for the following services and functions: (1) Field management and supervision; (2) production methods and selection of cane varieties; (3) financing of land purchased and of crop production as well as collecting the proceeds of crops and receiving payments under the Sugar Act; (4) purchases of fertilizer, equipment, and other items required for farm operations; (5) irrigation and drainage; (6) repair of farming

equipment; (7) cattle and pastures; (8) labor negotiations and relations; (9) representation in matters affecting the farm such as legislation and hearings; and (10) all records and accounts relating to the farm and its operations. Thus the manager of a farm is left largely with the responsibility for direct supervision of the laborers and the day-to-day operations of the place.

Each proportional-profit farm is required to bear its own operating costs, including charges for use of the land, services, depreciation, and interest. Laborers working on such a farm receive as an "advance" the regular wage commonly paid in the area, or that may have been fixed by Puerto Rican or Federal laws or regulations, or by collective bargaining with the laborers. The manager receives a fixed salary. These payments are included among the operating costs. The net profits of the farm are shared. The manager receives a fixed percentage and an amount is set aside as a reserve for the farm to take care of future contingencies. The remainder of the net profits is distributed among the farm workers in proportion to the days each has worked and to the wages or salaries received as an advance for the work performed on the farm. Whether or not an individual works on a proportional-profit farm is a matter which the worker chooses for himself. All of the laborers on a proportional-profit farm are free to join or organize any labor union or group without interference.

Operations of the Land Authority

Since it was established in 1941, the Land Authority has acquired by purchase or expropriation, or otherwise under the powers granted by the Land Law, slightly more than 102,400 *cuerdas* of land at a total cost approximating 15 million dollars. The greater part of this land was obtained in the process of enforcing the 500-acre limitation against corporate holdings.

Out of the total of 102,400 *cuerdas*, the Land Authority at the beginning of 1952 still owned more than 72,400 *cuerdas* of which slightly more than 62,500 *cuerdas* came under Title IV of the Land Law which provides for proportional-profit farms (table 42). Also under Title IV was 5,675 *cuerdas* of land that is being rented. Most of the remainder represented land which had been sold, ceded, or transferred for other purposes.

Table 42.—Total land owned, rented, or disposed of by the Land Authority up to 1952¹

Use and status	Approximate area
	<i>Cuerdas</i>
Title IV (owned)*.....	62,563
Title IV (rented).....	5,675
Title IV (transferred).....	3,728
Title V (transferred).....	6,382
Not assigned (owned)*.....	9,815
Land sold.....	6,760
Land ceded.....	7,239
Transferred to drainage area.....	239
Transferred to sugar <i>centrals</i>	19
Area in roads, etc.*.....	46
Total owned, rented, sold, or otherwise disposed of.....	102,466
*Total owned by the Land Authority..	72,424

¹ Source: Land Authority.

Most of the land owned by the Land Authority is in seven sugarcane producing areas, the holdings in each ranging from 6,600 *cuerdas* to more than 15,200 *cuerdas*. Of the 72,400 *cuerdas* owned by the Land Authority, slightly less than 43,000 *cuerdas* are adapted to cultivation and a little more than 17,900 *cuerdas* are suitable only for pasture (table 43). An additional 8,000 *cuerdas* are adapted only to forest. Some of the land owned could be improved by reclamation.

Table 43.—Classification of land owned by the Land Authority¹

Class of land	Area
	<i>Cuerdas</i>
Adapted to cultivation.....	42,973
Adapted only for pasture.....	17,942
Adapted only to forest.....	8,080
Other.....	3,429
Total.....	72,424
Area of total land that could be improved by reclamation:	
(a) drainage.....	² 5,600
	³ 4,200
	⁴ 480
	⁵ 1,200
(b) irrigation.....	⁶ 1,200

¹ Source: Land Authority.² Caño Tiburones.³ Loíza.⁴ Blasina area.⁵ Matamba-Regadera (Vega Alta).⁶ Lajas Valley.

In its use of farm land, the Land Authority has followed mainly the traditional pattern of crop production that prevails on the island. Out of the nearly 43,000 *cuerdas* of owned land adapted to

cultivation, nearly 37,500 *cuerdas* were devoted to the growing of sugarcane at the beginning of 1952 (table 44). From the very start of its operations the Land Authority has been growing sugarcane almost to the exclusion of other agricultural products. More recently this agency started to grow pineapples on an experimental basis, and the acreage of this crop is gradually being expanded. In 1951 more than 260 *cuerdas* of pineapples were harvested with a total production of 2,650 tons. Although the Land Authority owns approximately 17,900 *cuerdas* of land that is adapted only for pasture, little economic return is being derived from this rather large holding. The pastures are mostly poor, but they could be improved for profitable livestock grazing.

Table 44.—Total area of Land Authority owned land by specific crops or uses, 1952¹

Crop or use	Area
	<i>Cuerdas</i>
Sugarcane.....	37,488
Pineapples.....	1,077
Coconuts.....	1,058
Minor crops (fruits, vegetables, etc.).....	2,045
Land adapted to cultivation but not in crops....	1,109

¹ Source: Land Authority.

Slightly more than 1,100 *cuerdas* of land adapted to cultivation was not in crops at the beginning of 1952. The area of this land was somewhat greater than the total which the Land Authority had planted to pineapples.

Altogether, the Land Authority has a little more than 68,200 *cuerdas* of land in proportional-profit farms (table 45). Of this amount the agency owns a little more than 62,500 *cuerdas* and rents 5,675 *cuerdas*. An additional 9,800 *cuerdas* of land owned by the Land Authority is not included in proportional-profit farms. Although the agency itself produces some crops on this land, most of the area is either in pastures or is not tillable.

Out of the 68,200 *cuerdas* of owned and rented lands in proportional-profit farms, the Land Authority had at the beginning of 1952 a little more than 39,400 *cuerdas* devoted to the growing of sugarcane. An additional 550 *cuerdas* of sugarcane were on its other lands.

Table 45.—Use of land in proportional-profit and other Land Authority holdings, 1952¹

Crop or use	Proportional-profit		Land not assigned but owned
	Title IV owned	Title IV rented	
Sugarcane.....	<i>Cuerdas</i> 36, 938	<i>Cuerdas</i> 2, 474	<i>Cuerdas</i> 550
Pineapples.....	776		301
Coconuts.....	115	44	943
Forage crops.....	196	4	
Pastures, permanent.....	9, 921	834	
Minor crops.....	2, 045	140	
Fallow.....	1, 109	10	
Rough or swampy lands.....	8, 080	1, 889	
Pasture, rough or swampy lands.....			8, 021
Occupied by buildings, roads, etc.....	3, 383	280	
Total.....	62, 563	5, 675	9, 815

¹ Source: Land Authority.

Until the end of the 1949–50 crop year, the Land Authority had 48 proportional-profit farms in operation. Through a reorganization the number was increased to 83, these ranging from a little more than 300 *cuerdas* to the largest, in excess of 2,700 *cuerdas*. During the 1950–51 season the 83 proportional-profit farms harvested a little less than 32,400 acres (33,300 *cuerdas*) of sugarcane which was delivered to the mills serving each of the seven areas and produced more than 2,433,700 hundredweight of raw sugar (table 46). These 83

Table 46.—Acreage harvested, sugar produced by proportional-profit farms, 1950–51¹

Mill Area	Proportional-profit farms	Area harvested	Raw sugar produced
	<i>Number</i>	<i>Acres</i>	<i>Hundred-weight</i>
Cambalache.....	10	3, 970. 7	276, 627. 01
Plazuela.....	11	3, 472. 6	250, 356. 85
Canovanas (Loíza area).....	13	4, 583. 9	368, 278. 04
Constancia Toa.....	11	4, 468. 9	289, 652. 37
San Vicente.....	11	4, 151. 4	313, 952. 57
Fajardo.....	16	6, 647. 0	432, 429. 31
Guánica.....	11	5, 049. 9	502, 458. 47
Total.....	83	32, 344. 4	2, 433, 754. 62

¹ Source: U. S. Department of Agriculture, Production and Marketing Administration, Caribbean Area Office.

proportional-profit farms represented 0.5 percent of all the farms in Puerto Rico from which sugarcane was harvested that season, and the yield of raw sugar amounted to 9.83 percent of the island's total.

Most of the proportional-profit farms of the Land Authority show a profit, which is distributed among the workers on each farm at the end of the year in addition to the money which was paid to them in wages as an "advance" for labor performed. The most consistent losses have been experienced on those farms operated in the Fajardo and Loíza areas. The total loss among farms in these two areas was roughly a quarter million dollars for the crop year ended in 1951. The biggest losses have occurred on farms in the Fajardo area, which in total occupy more than 15,200 *cuerdas*, or slightly more than one-fifth of all the land in proportional-profit farms.

Altogether, the proportional-profit farms showed profits of slightly more than \$4,800,000 for the years 1944 through 1951 (table 47). During this period the workers on farms showing profits received an average of a little more than 60 percent of the total gain, or a yearly average of \$20.87 per worker. The actual distribution ranged from an average of \$12.44 received by 3,604 workers in 1944 to an average of \$26.20 received by 20,887 workers in 1950. The distribution of profits among workers in 1951 averaged \$24.66 among 31,214 workers. Out of the \$4,800,000 in total profits made in the 8-year period through 1951, a little more than \$2,900,000 went to the workers. The remainder represented the shares of profits paid to the farm managers and the amounts set aside as reserve for the farms to meet future contingencies.

Profits derived by the Land Authority from the operation of its two sugar mills, *Central Cambalache* and *Central Plazuela*, are not shared, but the workers in these mills do get somewhat higher wages than in private mills and they receive annual production bonuses. Both mills usually operate at a profit to the Land Authority. They grind sugarcane that is received both from private growers and from proportional-profit farms.

During the 1950–51 season, *Central Cambalache* ground 372,800 tons of sugarcane from 1,002 farms and produced slightly more than 814,000 hundredweight of raw sugar. This mill showed a net profit of more than \$280,000 for the year. In the

Table 47.—Profit distribution among proportional-profit farm workers, 1944–51 ¹

Year	Total profits proportional- profit farms	Amount paid workers out of profits	Percent of total profits paid workers	Number workers sharing profits paid out	Average paid per worker out of profits
1944.....	\$53,655.96	\$44,817.82	83.528	3,604	\$12.44
1945.....	163,416.34	115,619.45	70.751	9,533	12.13
1946.....	431,986.63	267,538.81	61.932	15,105	17.71
1947.....	560,350.34	355,346.85	63.451	16,763	21.21
1948.....	465,976.74	360,222.14	77.305	19,325	18.64
1949.....	970,255.98	450,213.94	46.402	23,070	19.52
1950.....	966,205.55	547,266.13	56.641	20,887	26.20
1951.....	1,219,418.83	769,742.44	63.127	31,214	24.66
Total.....	4,831,266.37	2,910,967.58	60.253	-----	20.87

¹ Source: Land Authority.

same season, *Central Plazuela* ground nearly 261,500 tons of cane from 705 farms and produced somewhat more than 587,300 hundredweight of raw sugar. The net profit for the year was slightly more than \$200,000. Operations in both mills were at a little higher level in the 1949–50 season, *Central Cambalache* yielding a net profit of more than \$317,000 while *Central Plazuela* returned only a little more than \$135,000 in contrast with a loss of around \$40,000 for the previous crop year. The two mills represent an important source of income which the Land Authority can use to purchase or reclaim land for proportional-profit farms or to finance other programs.

An analysis of operations in the sugar industry of Puerto Rico made by the Sugar Branch of the Production and Marketing Administration, United States Department of Agriculture, shows that the tonnage of sugarcane harvested per acre from farms of the Land Authority is usually higher than the yield obtained by the category of large private producers on the island who harvest 200 or more acres annually. This study, which covered the years 1945–46 to 1948–49, also shows that despite the higher tonnage of cane per acre harvested, the Land Authority's labor cost per hundredweight of sugar produced is greater than that of the large private growers, as is the number of man-hours required per hundredweight of raw sugar recovered from the cane (table 48). Average hourly earnings of Land Authority workers in sugarcane are shown by the study to average only fractionally higher than those of workers on the large privately operated farms. These earnings, however, are exclusive of

the Land Authority's profit-sharing distributions among its workers and represent only the "advances" paid for work performed. Since these "advances" usually are in line with the regular wage commonly paid in the particular area, they are comparable with the hourly earnings of workers on private farms.

The production of sugarcane on Land Authority farms during the 4-year period covered by the study ranged from an average of 31.1 tons per harvested acre to 38.4 tons, or an average of 35.2 tons for the 4 years. This compares with an average ranging from 30.3 tons per acre to 35.9 tons, or an average for the same period of 33.475 tons per acre for those large producers who harvest 200 or more acres of cane annually. The average yield of sugarcane on Land Authority farms is also higher than the average on all farms on the island. This is natural and logical, inasmuch as the lands devoted to sugarcane on Land Authority farms are, in general, suited for this crop, and all lands growing sugarcane on the farms in Puerto Rico are not, on the whole, as good.

The amount of raw sugar recovered per ton of sugarcane harvested by the Land Authority ranged from an average of 2.16 hundredweight to 2.3 hundredweight, or an average of 2.23 for the 4-year period. This is due to the fact that much of the land producing this cane is in areas where sucrose yields are low. Recovery by the group of large private producers ranged from an average of 2.29 hundredweight of raw sugar per ton of cane to 2.39 hundredweight, or an average of 2.33 hundredweight for the same years.

Table 48.—Labor requirements and costs, Land Authority and privately owned farms ¹

	Land Authority	Private producers ²
Sugarcane harvested per acre:	<i>Tons</i>	<i>Tons</i>
1945-46-----	31. 1	30. 3
1946-47-----	34. 3	35. 2
1947-48-----	38. 4	32. 5
1948-49-----	37. 0	35. 9
Average-----	35. 2	33. 475
Raw sugar recovered per ton of sugarcane:	<i>Cwt.</i>	<i>Cwt.</i>
1945-46-----	2. 30	2. 39
1946-47-----	2. 20	2. 33
1947-48-----	2. 16	2. 31
1948-49-----	2. 26	2. 29
Average-----	2. 23	2. 33
Man-hours per hundredweight of raw sugar recovered from sugarcane:	<i>Man-hours</i>	<i>Man-hours</i>
1945-46-----	8. 6	8. 4
1946-47-----	8. 1	7. 6
1947-48-----	7. 3	7. 0
1948-49-----	6. 2	5. 6
Average-----	7. 55	7. 15
Labor cost per hundredweight of sugar:	<i>Cents</i>	<i>Cents</i>
1945-46-----	238. 6	232. 0
1946-47-----	256. 7	240. 1
1947-48-----	249. 7	243. 8
1948-49-----	220. 8	191. 6
Average-----	241. 45	226. 875
Average hourly earnings: ³		
1945-46-----	27. 8	27. 7
1946-47-----	31. 7	31. 7
1947-48-----	34. 1	34. 8
1948-49-----	35. 5	34. 3
Average-----	32. 275	32. 125

¹ Source: Sugar Branch, Production and Marketing Administration, U. S. Department of Agriculture.

² Producers in Puerto Rico who harvest in excess of 200 acres annually.

³ Earnings of Land Authority employees are exclusive of profit-sharing distributions which averaged 3.7 cents per hour in 1946; 4.3 cents in 1947; 2.1 cents in 1948 and 2.7 cents in 1949.

NOTE: Data reflect total labor requirements other than administrative employees.

The number of man-hours of labor required per hundredweight of raw sugar recovered from cane shows a progressive decrease for both the Land Authority and the large private producers. This decrease, indicating a growing efficiency in production, has been greatest, however, among these private producers. The labor per hundredweight of raw sugar recovered by the Land Authority dropped progressively from an average of 8.6 man-hours in 1945-46 to 6.2 man-hours in 1948-49.

The large private producers reduced their labor requirements from 8.4 man-hours in 1945-46 to 5.6 in 1948-49.

While reductions have also taken place in the labor cost per hundredweight of raw sugar recovered from cane, they are more marked for the group of private producers. The Land Authority's labor cost during the 4-year period ranged from \$2.567 per hundredweight to \$2.208, or an average of \$2.4145 for those years. This compares with labor costs for the large private producers ranging from an average of \$2.438 per hundredweight to \$1.916, or an average of \$2.26875 for the 4-year period.

Average hourly earnings of workers on sugarcane farms of both the Land Authority and private owners increased each year during the 4-year period covered by the study. Exclusive of profit-sharing distributions, earnings of workers on Land Authority sugarcane farms rose steadily, from an average of 27.8 cents per hour in 1945-46 to 35.5 cents per hour in 1948-49. For the period as a whole, the earnings of these workers averaged 32.275 per hour. The earnings of workers employed by the large private sugarcane producers went from an average of 27.7 cents per hour in 1945-46 to 34.3 cents in 1948-49, or an average of 32.125 per hour for the 4-year period. The profit-sharing distributions among workers on Land Authority farms increased the hourly earnings of these employees by an average of 3.7 cents per hour in 1945-46. In 1946-47, the amount distributed averaged 4.3 cents per hour. It averaged 2.1 cents per hour in 1947-48, and 2.7 cents per hour in 1948-49.

The Land Authority is a major employer of sugarcane workers on the island, but it is apparent that the average productivity of labor on its farms has not been increasing to the same extent as on farms of private producers who annually harvest 200 or more acres of cane. The main reason for this lies in the fact that the Land Authority attempts to provide employment for relatively more workers than are really required for the tonnage of cane produced. This tends to reduce both the efficiency and productivity per worker employed. It also adds to production costs.

What actually takes place is indicated by a comparison of the number of workers employed in sugarcane by the Land Authority and the total for

the industry as a whole. For example, the Land Authority produced a little more than 1,169,000 tons of sugarcane in 1949-50, or about 11 percent of the total production in Puerto Rico, and employed a total of 32,703 workers. That same year, the highest number of workers employed in sugarcane by the entire industry on the island totaled 161,000. If the Land Authority had employed workers in the same proportion per ton of cane as were employed by the industry in general, this agency would have engaged only 17,700 workers in sugarcane instead of the 32,703 which it did employ. In other words, it appears that the amount of work available in sugarcane on Land Authority farms was shared among almost twice the number of workers, which gave each worker only about one-half the opportunity for being as fully employed as those engaged in the entire sugarcane industry. This is undesirable from an economic standpoint since it serves as a drag on the efficiency of labor and does not permit workers to achieve their individual levels of productivity. It does, however, provide some work for those who, in the absence of other alternatives, might otherwise be unemployed. But in the process it pulls down the possibilities for earnings of those workers who could be more fully employed in sugarcane by the Land Authority if the sharing of work with others was not necessary.

Land Policy and the Land Authority

As an instrumentality created by the Land Law of Puerto Rico, the Land Authority is responsible for enforcing the 500-acre limitation on corporate landholdings on the island which originally was prescribed by the United States Congress in 1900. At the time the Land Authority was established, it was estimated that corporations held 194,500 acres of land in violation of the 500-acre limitation. In the first 5 years of its existence, the Land Authority moved ahead with an aggressive program of acquiring land from these holdings. By the end of 1947 the agency had bought 67,763 acres from the corporations. During the next couple of years it acquired some additional land. Altogether the Land Authority obtained 95,502 acres of land, or approximately 49 percent of the total land earlier estimated as being held by corporations in violation of the 500-acre limitation. There the program has stood. At the beginning of 1952 the Land Authority had no plans for acquiring

additional lands under the 500-acre restriction on corporate holdings.

The principal activity of the Land Authority is the operation of the proportional-profit farms which contain a little more than 62,000 acres of owned land and on which the production of sugarcane is the most important enterprise. At the same time, the enforcement of the 500-acre limitation on corporate landholdings is at a standstill. In this situation it is apparent that the land policy of Puerto Rico as enunciated by the Legislature in the Land Law has reached a point where some major decisions have to be made to determine the future course so that the economy as a whole may benefit to a greater extent than it has so far.

Land is scarce in Puerto Rico and it is growing scarcer as the population increases. The physical area of the island cannot be stretched, but to the extent that production can be increased the effect on the economy will be almost the same. More production is needed both in industry and in agriculture if there is to be more adequate employment for a greater number of people. This means not only an expanded volume in total output but also more production per person. Such a goal cannot be achieved without some pain in the process of change.

The Land Authority is in position to set the pace that needs to be followed in the development of agriculture in Puerto Rico. Unfortunately, however, by its concentration on the production of sugarcane, this agency has not elected such a course. Only relatively recently has there been any inclination to engage in the commercial production of a crop other than sugarcane and that was to undertake the growing of some pineapples. And even in the production of sugar the Land Authority has not been a pacemaker. This is evidenced by the labor requirements and costs in producing a hundredweight of raw sugar as compared with private producers who harvest 200 or more acres of sugarcane annually.

Except for the fact that the Land Authority has enabled several thousand workers to share the work with those that otherwise would be employed on the same acreage of sugarcane, and also to share in the possible distribution of any profits from the farms on which they labored, this agency really has not contributed to a net increase in production to the extent that could properly and reasonably be expected from it. In this one respect, the Land



Planting time on a small farm in Puerto Rico. Most of the work in growing a crop is done by hand. In many sections of the island mechanization is limited by the topography of the land.

Authority's acquisition of land from corporations under the 500-acre limitation has represented little more than a transfer of land from one big owner to another. And in the process of operating this large holding of land, the Land Authority unwittingly has had to assume many of the characteristics and the problems of the very same corporate entities it was obliged under the law to destroy. In addition, being a public agency, it is subject to various kinds of outside pressures which are not conducive to maximizing production efficiency. Through all of this the fulfillment of the objectives of the land policy as established under the Land Law has suffered.

On the other hand, the social benefits that have resulted from the Land Authority's operations cannot and must not be discounted. This agency has made some real contributions to the welfare of thousands of sugarcane workers, *agregados*, and others who otherwise would have endured greater hardship and insecurity in their circum-

stances. But even for these people who have already been assisted and those who still need to be helped there is much to be gained in the long run by an approach to the land problem that concerns itself more with the need for expanding production on a broad front rather than with attempting to cater primarily to the immediate situation. Thus in moving forward toward the fulfillment of the land policy that has already been established by the Land Law, the Land Authority must broaden its concepts and in an improved way merge the desirable economic and social objectives into a compatible and acceptable pattern of operations.

It is necessary to be vigilantly on guard against the breaking up of large landholdings simply for the sake of consolidating them into the hands of a single owner or of dividing them into small units such that a unit cannot possibly provide a decent living for the family that will own it. The purpose should be to maximize production in

a way that will bring the greatest net benefit to the economy as a whole. It is in this connection that the family-type farm, of a size adequate for the productive use to which it is to be put, deserves special consideration in the development of agriculture in Puerto Rico.

First, however, it is necessary to know exactly how large a family-type farm should be for the different kinds of farming enterprises that may be undertaken in the various sections of the island. Obviously, a family-type farm specializing in the production of sugarcane would have different acreage requirements than would a family-type farm specializing in dairying or in the production of diversified crops. Whatever the acreage needed, the farm needs to represent an economic unit.

The information needed to determine what should constitute an efficient family-type farm among the various enterprises and combinations possible in the different sections of the island can be obtained only by thorough study and analysis. Studies should be made for all types of farming activities, including the production of sugarcane. The basic responsibility for such a study and analysis should rest with the Puerto Rican Experiment Station and should be carried out in cooperation with other agricultural agencies on the island. In this work it would be highly desirable to enlist the cooperation of agencies of the United States Department of Agriculture, especially the Bureau of Agricultural Economics and the Sugar Branch of the Production and Marketing Administration.

In the case of sugarcane, for example, a study to determine the most efficient size for a farm specializing in this crop might include two main phases. In the initial phase, a review would be made of all available studies of costs of production and of farm operations that have been conducted in Puerto Rico during the last 10 years, including the cost studies made by the Sugar Branch. Such an analysis would indicate production costs for farms in several size brackets and would further indicate the type of cost advantage associated with the farms in each group. In addition, cost trends for the farms in each group would provide a diagram of the changing situation. This phase of the study would be indicative of the most efficient size of sugarcane farm operations but would not provide conclusive information for

three main reasons. First, the methods employed on certain farms might well be adapted to farms in other size brackets even though not presently used on such farms; second, there may be desirable methods not now in use but available for use by farms of certain size brackets; and third, cost differences to some extent reflect merely variations in individual managerial ability in areas unrelated to farming methods. Therefore, to meet the shortcomings of the first phase of the study, the second phase might well be a farm engineering survey of the farming practices on various size operations; of the feasibility of extending desirable practices characteristic of certain farms to farms of larger or smaller acreages; and the possibility of introducing to Puerto Rican farms of one or more size groups methods not now in use. The findings of such a survey when integrated with the review of production-cost history would be reasonably conclusive as to the most efficient size for Puerto Rican farms, irrespective, of any social considerations.

To the extent that family-type farms are found to be desirable as means of maximizing and diversifying production and improving rural living, they should be encouraged to the fullest degree possible. The farm ownership program of the Farmers Home Administration has been very successful in Puerto Rico, but this agency has been unable to move ahead in the establishment of family-type farms as rapidly as might be desired. In recent years the agency has been unable to utilize a big part of the nearly one-half million dollars allocated annually to Puerto Rico for this program. There are various reasons for this and they tie in directly with the land policy problem that exists on the island.

In the first place, the land values of sugarcane farms have been highly inflated and there has been a strong demand for such acreage at prices higher than the Farmers Home Administration is authorized to lend for the establishment of family-type farms. Land suitable for family-type dairy farms has not been offered also because of its highly inflated value and because much of this land was also in demand for the production of sugarcane. The Farmers Home Administration has been unsuccessful in obtaining offers of tobacco farms for sale, either of the family-type size or of larger farms suitable for subdivision. The only tobacco farms offered have been those that are not

suitable for the production of tobacco and which can only be used for pastureland and the growing of small acreages of minor crops. In the coffee-producing sections of the island, the acreages offered for family-type farm use have been only those on which the coffee has been poorly cultivated or neglected for such a long time that it would take several years of intensive cultivation to develop the acreage into efficient coffee farms.

The Farmers Home Administration has attempted to obtain some land from the Land Authority for the establishment of family-type farms. Although the Land Authority has offered several farms for the farm-ownership programs, the Farmers Home Administration has in recent years been able to make loans for only enough land to subdivide into 16 family-type farms. On one tract of 2,500 acres, which was to be subdivided into 55 family-type farms, the Farmers Home Administration was unable to lend as much money as the Land Authority was asking for the acreage. In the case of several other tracts of land, the Land Authority, after agreeing with the Farmers Home Administration on the prices that were to be paid, was unable without too much difficulty to remove the squatters, and for this reason the transactions were not completed.

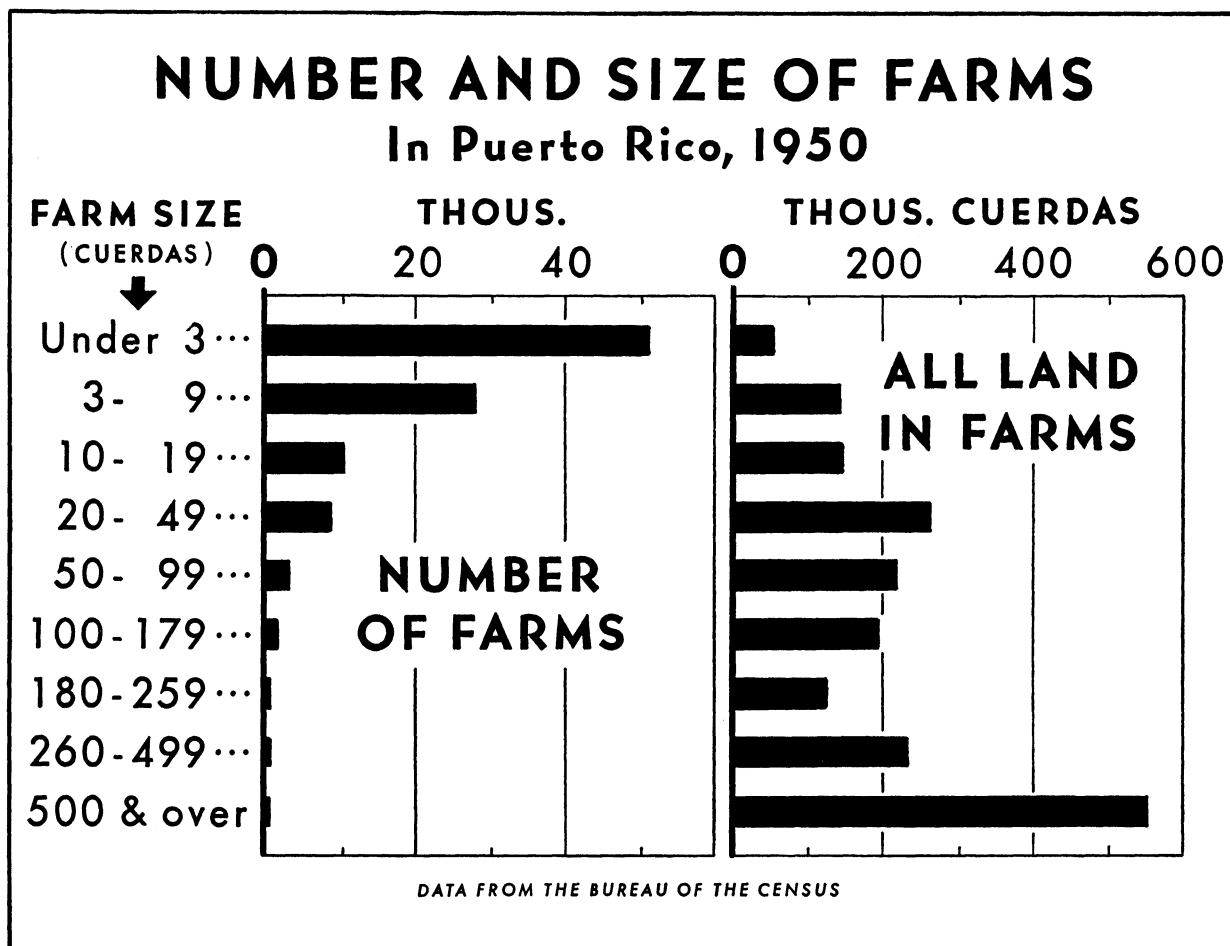
Looking ahead to the course that should be followed in carrying out the objectives of the Land Law of Puerto Rico, it is clear that the land policy enunciated by the Legislature now stands at the crossroads. The situation, however, requires moving forward in a positive direction for the constructive purpose of improving the utilization and the tenure of the land in order to bring broader and more permanent benefits to both the people and the economy.

Experience in Puerto Rico has demonstrated that operators of large farms do not make the most effective use of all their land. They specialize in the production of a single crop such as sugarcane, and land not adapted to such a crop often remains virtually idle. On the other hand, family-type farms greatly improve the utilization of lands which may have been poorly employed when in large holdings. These owner-operated farms lend themselves more readily to diversified agricultural production, and that is the kind of farming which needs to be encouraged in order to step up local food production and increase agriculture's contribution to the island's economy.

But as long as land is so tightly held as it is in Puerto Rico, there is little opportunity for individuals to become farm owners. The 1950 census shows that about one-half of all the land is in farms having 175 *cuerdas* and over. These farms represent only 3.2 percent of the total number of farms on the island. The greatest concentration of landholdings, however, is in farms of 500 *cuerdas* or more in size. In 1950 there were 471 such large farms, including those owned by the Land Authority and those still possessed by corporations. While these farms of 500 *cuerdas* and over represented less than 1 percent of the total number of farms on the island, they contained 30 percent, or more than 554,000 *cuerdas* (538,000 acres), of all the land in farms. Only a little more than 10 percent of this total acreage in large landholdings was controlled by the Land Authority, and most of this in proportional-profit farms.

The fact that a great deal of land is still monopolized by a relatively few owners suggests the need for following through with measures to improve its distribution. The Land Authority might well carry to completion the program of divesting corporations of landholdings that are in violation of the 500-acre limitation. In addition, the Land Authority should be in position to buy other large holdings whenever it is possible to do so in order to improve the utilization and the distribution of such land. All land acquired by the Land Authority, whether from corporations or private owners, should be made available to promote more widespread individual ownership of economic farming units. Such land should first be offered to the Farmers Home Administration for subdivision and disposal under its family-type farm-ownership program at a price that will permit owners to pay off out of earnings that may reasonably be expected from the land over a period of years. In its disposition of family-type farms, the Farmers Home Administration needs some means of making sure that there will be no subsequent subdivision or regrouping of such farms.

The fact that some of the Land Authority's proportional-profit farms have operated at a loss in producing little else but sugarcane suggests the need for a thorough examination of their operations to determine in what ways agricultural output from these farms may be raised. The contributions of these farms to the economy of the



Most of the farms in Puerto Rico are quite small. Those under 3 cuerdas in size total 51,157 and all these *parcelas* contain only 53,515 cuerdas of land. Farms of 3 cuerdas or more in size total 53,112 and have 1,844,886 cuerdas. Most of this land is contained in a relatively small number of large farms.

island probably could be increased by giving emphasis to diversified production instead of concentrating on the growing of sugarcane. Otherwise, it might be desirable to subdivide these farms for disposal as family-type farms. The land in these farms could be offered to the Farmers Home Administration for subdivision and subsequent sale as suitable family-type farms. But in doing so, the Land Authority, as a governmental agency, would need to be more concerned with furthering the land policy objectives for the benefit of the people and the economy than with making profits from land sales at inflated prices which do not reflect the true earning power of the land. On the remaining proportional-profit farms that are profitable producers of sugarcane, the Land Authority should be able to concentrate on further improving the production

of this crop and at the same time aggressively move to diversify their agricultural operations so as to point the way for other large farm operators.

In improving the system of land tenure in Puerto Rico, one of the first aims should be to give more impetus to the family-type farm. But this need not preclude the possibility of opening for farm families an opportunity for land ownership and operation through the medium of cooperative action. In fact, the desirability of such a course might well be determined by converting one of the good proportional-profit farms into a bona fide cooperative enterprise that would be owned and controlled by the members themselves who also would work on the farm. Also, in view of the scarcity of land for special purposes, such as for growing pineapples, the Land Authority should

have no hesitation in making the necessary land available either by sale or rental to individuals who will do an equally good job of farming it. Ordinarily, there is no particular virtue in a governmental agency farming land if the same results can be achieved through private initiative. In the long run, the objective should be for the Land Authority to get out of its present role of being in control of substantial acreages, and the land should be owned in economic units by individual farmers in a way that is consistent with sound land policy for Puerto Rico. After all is said and done, agricultural progress depends primarily on the farm family and its sense of pride in farm ownership and accomplishment on the land. In the case of the sugar mills operated by the Land Authority, these should eventually be turned into cooperative enterprises that would be owned and controlled by sugarcane growers themselves.

Tax Policy and Agriculture

Many of the adjustments needed in the agriculture of Puerto Rico hinge upon the willingness of farmers and others to make investments in improvements or to assume added risks. Experience has shown that there is very little action without some incentive serving as the motivating force. In Puerto Rico the need for offering incentives to encourage industrial enterprises has been realized for some time. As far back as 1919, a law was passed exempting new industries from the payment of Puerto Rican taxes. Other similar laws were enacted in later years. But it was not until 1947 that the Puerto Rican Legislature enacted a tax-exemption law to give local and mainland investors strong inducements to establish new industries on the island.

Agriculture in Puerto Rico has not received the same attention or treatment that has been accorded to industrial development. As a matter of fact, the tax system on the island has in many instances actually hindered agricultural production instead of having promoted it. Because of the urgent need for revenues with which to finance the ever-increasing demand for public services, it is understandable why an examination and orientation of the tax policy with respect to agriculture has not been made. But the failure to do so has been costly to the economy. Agriculture, like industry,

requires reasonably adequate incentives if growth and development are to result. At least there should be no undue burden placed in the way to thwart desirable progress.

Incentives of one kind or another have played a major role in the development of the sugar industry of Puerto Rico since the beginning of the present century. The first major incentive was provided by the inclusion of Puerto Rico within the United States system of tariff protection, which permitted the island's sugar to enter the mainland markets free of duty. This advantage over other leading producers, such as Cuba, induced many capitalists on the continent to invest substantial sums of money in the sugar industry of Puerto Rico. The next major event was the enactment of the Sugar Act by Congress in 1934 which, while imposing controls, brought to the sugar industry market stability and assurance of a mainland outlet for at least the quantities specified by the quota. Moreover, since 1934 United States growers have been receiving, under the Sugar Act, payments which add to the income received from their sales of sugar. These payments have meant much to the sugarcane producers in Puerto Rico, adding in 1950-51 alone more than 17 million dollars to their income. On the average, the payments received by the island's growers amounted to about \$47 per acre of sugarcane harvested, and raised their return from raw sugar by 69 cents per hundredweight, or \$1.76 per ton of cane. Whereas the Sugar Act imposes on the producers certain obligations, principally relating to labor and wages, these are outweighed by the various benefits derived from it. This is evidenced by the expansion in production and the increase in the number of cane growers that took place between 1934 and 1952.

The advantages given to sugar by Federal action since the turn of the century have been such that this industry has come to be the backbone of the economy of Puerto Rico. The assurance of a protected and stabilized market contributed substantially to the fact that the industry has had at its disposal all of the facilities in the fields of credit, production, processing, and marketing that were needed for proper and successful development. The resulting high level reached by the sugar industry in Puerto Rico has contributed materially to the growth of the economy.

But other agricultural enterprises on the island were disadvantaged by the fact that they did not hold the incentives which the production of sugar could offer. As a matter of fact, dairying has been the only farm enterprise able to show any appreciable expansion in competition with the production of sugarcane during the second quarter of the present century. And even it has not developed to the extent that could reasonably be expected in view of the increase in milk consumption in Puerto Rico and the degree of relative price stability this product has enjoyed locally. On the other hand, there are other crops and products with good possibilities for expansion and development which, although they might well yield an income per acre equal to or larger than sugarcane, have not been able to compete with cane because they do not have the advantages of being similarly organized for production and marketing. And yet, the land re-

sources needed for these other crops and products are available and waiting to be brought into more effective use.

Much can be done by the Puerto Rican Government to encourage private initiative to swing into action. This calls for policies that will stimulate necessary investments and promote the adoption of practices and the establishment of facilities required for the proper functioning of the production, processing, and marketing processes. Within such policies will be found the direct and indirect incentives required for achieving desired improvements in the production and flow of products from the island's farms.

Incentives do not necessarily involve the payment of Government money to farmers or others as an inducement to get them to make desirable changes or to assume added risks. Frequently public measures such as the building of a market



This new stretch of concrete road links Río Piedras and Caguas. It will eventually extend through the mountainous interior to the southern coast of the island.

facility, improvement of roads, or the provision of needed services offer the incentives required. As a matter of fact, the most important incentive for diversifying agriculture to increase food production on the island and improve its distribution may be expected from the construction and operation of the central market proposed for the San Juan area. Tax adjustments and improvements in the system of taxation also offer incentive possibilities. And, of course, direct payments may be necessary in some cases such as in the island's coffee industry, where they are already being made by both the Puerto Rican and Federal Governments as a means of helping producers to finance the costs which they alone cannot bear in rehabilitating the plantations to increase production and also conserve soil resources.

Taxes paid on the island are of three main types: property, excise, and income taxes. Although the property tax in Puerto Rico is a relatively small item in the general budget of the island Government, it is the principal one in the budgets of the municipal governments. This tax applies to land, all buildings, including dairy barns, tobacco curing barns, packing sheds, etc., and also to equipment, livestock, and inventories of supplies. The tax rate paid throughout the island varied in 1950-51 from 2.19 percent to around 3.17 percent of assessed valuations that lacked any uniform base. Tax receipts from rural and urban property totaled around 13.9 million dollars, of which 5.5 million dollars went to the island Government and 8.4 million dollars to the municipalities. Insular excise taxes in 1950-51 yielded 44.5 million dollars and an additional 1.3 million dollars, mostly from excises and permits, went to the municipal governments. Income taxes returned to the island Government 27.7 million dollars. The total revenue derived by the Puerto Rican Government from all sources, local and Federal, amounted to 123.1 million dollars in 1950-51.

The main purpose of taxes is to raise money to defray the costs of governmental functions and services. However, as incidental to this purpose, taxes have long been recognized and legally upheld as possessing directional power. They may impede or encourage certain courses of action. This is true in the case of land taxes, for example, and may be illustrated by the many instances in which taxes on forest land have been adjusted to the nature of the forest crop through the adoption of

a low annual tax and the application of yield or severance taxes at the time of the timber harvest. The underlying theory of this means of taxation is that it provides an incentive to private individuals to practice forest production.

The property tax burden on any given piece of land at any particular time is the product obtained by multiplying the assessed valuation of the land by the tax rate. Assessments and rates are the two variables in a determination of the tax burden on land. Thus the tax burden may be adjusted by changing one or both of these factors. And in the end, it is the total property taxes that a farmer pays on his land that is a measure of his land tax burden.

Since they are a charge against land, taxes enter into the cost of production. And as a cost of production, taxes affect land use to the extent that the amount of the tax is a determining factor in the production process. Land taxes are costs that cannot be directly passed along to someone else since prices of agricultural products are basically determined by supply and demand in a situation which is beyond the control of the individual. Thus, land taxes are a cost of production that the landowner bears.

Although land values in Puerto Rico increased sharply since World War II, the fact is that the rural areas have been bearing a greater share of the tax burden on land than have the urban areas. Farm property has been overvalued relative to urban property, and in the rural sections the farms of lower productive capacity have been overvalued in relation to the better farm properties. Shortly after the war, an important step was taken toward a more equitable adjustment of property taxes through a scientific reassessment by the Puerto Rican Government of all taxable real property. As long as the principles of the revised assessment system are followed the island has prospects of having a more equitable distribution of the total property tax burden, with rural property, particularly the smaller and lower valued properties, bearing a relatively smaller part of the Puerto Rican tax load. When this system of assessment becomes fully effective, it should have a beneficial influence toward improving the use of land for agricultural purposes.

Some have advocated increasing taxes of land to force it into desirable uses. These advocates, for example, would raise the tax load on idle land

that is suited to tillable crop production or for improved pastures. This type of tax adjustment would appear much less satisfactory than the lowering of taxes as a production incentive. The administration of a punitive type of tax, assuming it to be constitutional, would recognizably be a most difficult task in view of the problems associated with the necessity of classifying tracts of land by degree of "idleness" as a basis for the proposed tax increases.

There is, however, the problem in Puerto Rico of the acquisition of land purely to provide "safe storage" for capital, or for speculative purposes. Considerable land is contained in the rather large holdings of owners who have made such investments. Many of the owners of such property are not concerned with improving the land or making it produce. They are content just to hold it. Meanwhile, the people are denied the products which this land could produce, the availability of land on the island gets tighter and tighter as the population increases, and the pressure forces land values higher.

Puerto Rico, with its scarcity of land and its need for getting the most production out of every acre there is, cannot afford to have large areas in the hands of owners not interested in putting the land to work so that the whole economy may benefit, as well as themselves. For this reason large accumulations of farm land that will not be properly maintained in production or improved should be discouraged.

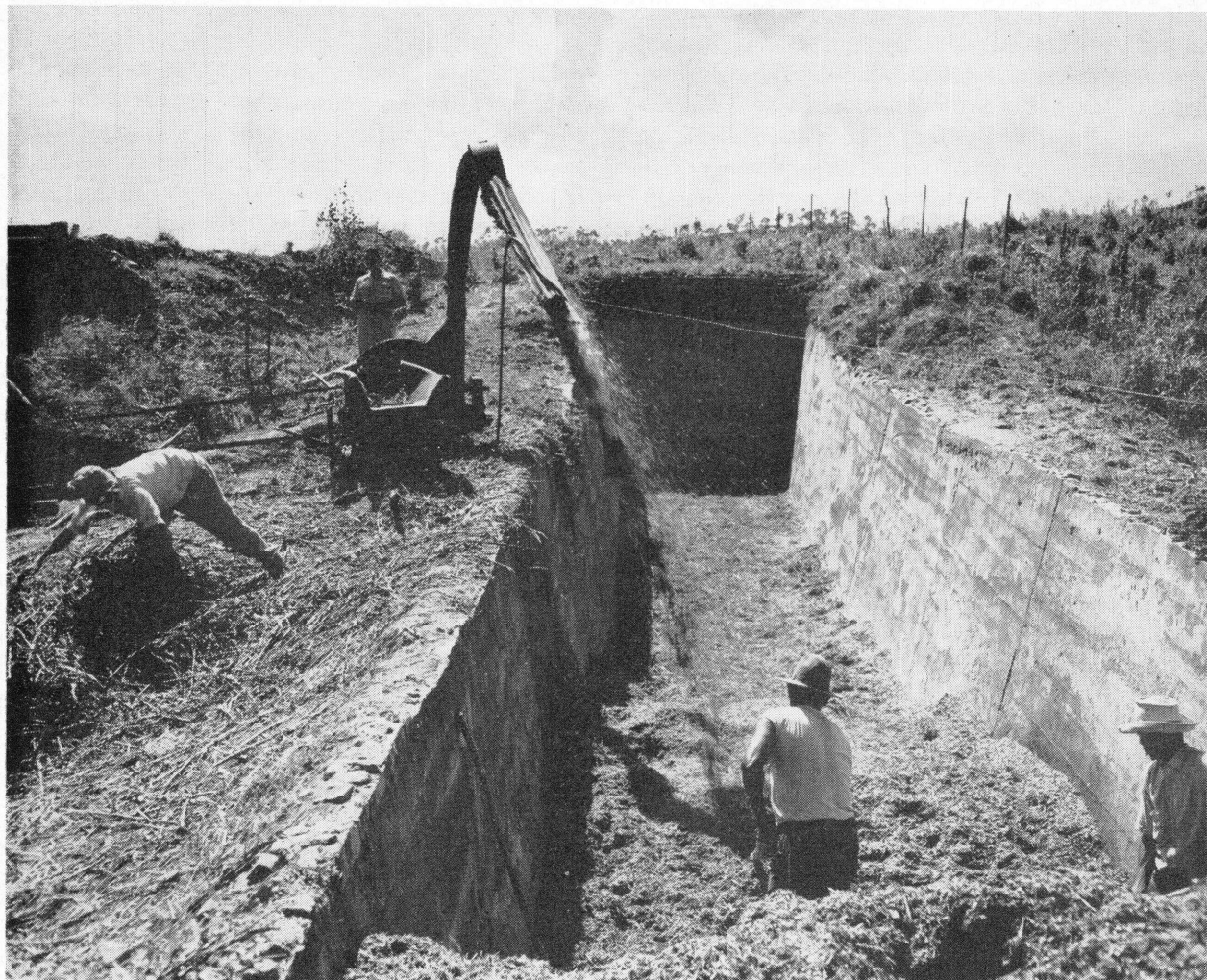
This could be done by the enactment of a special capital gains tax which would apply to those who owned or controlled 100 *cuerdas* or more of land, and impose on these owners at the time of sale or transfer a rather heavy tax on the gain in value of all land suitable for agricultural purposes that may be involved in any such transaction. With such a tax there would have to be an exemption, or a considerably lower rate of tax, for any acreage of farm land sold or transferred which actually had been reasonably improved or farmed by the owner so as to maintain production. This would be an incentive for proper land use and it would afford protection to bona fide farmers and others who properly utilize their land as a medium for production.

In certain situations tax adjustments may serve more effectively as an incentive for the improve-

ment of land resources and the expansion of agricultural production when they are employed in connection with other programs, or as a supplement to other measures. For instance, on land subject to serious erosion, the lowering of taxes in the interests of conservation plus some direct benefit payments to bring about desirable shifts in land use or farming practices could provide a feasible and worthwhile combination for stimulating effective action and obtaining desired results. Thus tax reduction and incentive payments would supplement one another in helping individual owners bear the costs of land use adjustments, and the public would benefit from the resulting conservation and improvements.

From the standpoint of the overall picture, there is a need for removing certain taxes which in one way or another have the effect of restricting production, slowing down or limiting distribution, or retarding consumption of agricultural products produced in Puerto Rico. This applies especially to excise taxes and taxes on certain types of equipment and farm property. In cases where it is essential to encourage investments in new construction or improvements of permanent structures or making installations for developing the production, processing, or handling and distribution of agricultural products, additional incentives could be supplied through tax exemption for a specific number of years or through income-tax credits that would account for some part of the investment in the year that it was made. If such a course is followed, the tax exemption or income-tax credit should be granted only to those who meet the requirements that may be laid down by the Puerto Rican Secretary of Agriculture in order to make sure that the incentive provided for encouraging the investment serves the purpose for which it is intended.

Tax policy in Puerto Rico should fully recognize the island's need for building up its agricultural plant and the allied facilities and services required to process, handle, and distribute the various products from the time they leave the farm until they reach the consumer. The tax policy in effect for so many years has been of little help to the development of a diversified agricultural industry on the island. In some instances, the psychological effect more than the tax rate itself has actually hindered real progress.



Filling a trench silo to provide necessary supplementary feed, especially when pastures are low. Too few farmers in Puerto Rico use silage for their livestock. A great increase is needed in the number of silos, particularly in areas that suffer from seasonal drought.

The dairy industry of Puerto Rico offers an excellent opportunity for improvement and expansion in all of its phases, but without some stimulation it is apparent that the necessary investments will not be made. Certain tax incentives would be very helpful to the industry, and the economy would actually benefit by a great deal more than the immediate small loss in revenue. For one thing, an increase in local milk production would reduce the need for imports and result in a retention of money that now leaves the island. This alone would be a big item in addition to the benefits derived by the economy from the increase in employment and added business activity which an expanded dairy industry would provide.

As a means of increasing the number of dairy farms and the number of cattle, it would appear

advisable to maintain a tax exemption on dairy animals in herds producing milk for market. The Puerto Rican Government has had a tax on livestock in effect for some time. Besides stirring up much resentment among farmers, there is general agreement that the administrative cost connected with levying and collecting the tax on livestock has been high in relation to the revenue obtained from it by the local Government. In addition, property tax exemption might well apply to barns, silos, and other farm structures in order to provide an incentive for increasing the farm facilities required for efficient milk production.

In the case of silos, for example, anything that would stimulate their construction and use would be extremely beneficial. Although some of the more progressive dairy farmers have recognized

the value of silos, there are only between 50 to 60 of them on the island. Assuming that these silos have an appraised value for tax purposes totaling \$60,000 or so, the revenue derived from taxing them amounts to around \$1,500 for the Treasury of Puerto Rico. If the abolition of property taxes on silos proved to be an incentive for increasing their numbers, this small loss to the Treasury would be more than made up in other ways. From the standpoint of the farmer, the use of a silo in Puerto Rico would virtually treble the productive capacity of a good acre of grassland. It would also reduce the risks of the lack of feed during periods when rainfall is short. Action stimulating the construction of silos would result in a decidedly more efficient use of pasture and grassland, as the preparation of ensilage from grasses and also from sugarcane tops would enable farmers to keep more animals and to feed them with greater economy.

Dairying in Puerto Rico depends largely on the use of grass as feed. While the island has an estimated 664,000 acres of lands which are best suited for the production of pastures and forage crops, most of the pastures are poor and have a low carrying capacity. These grasslands need to be improved to provide more feed for more animals at a lower cost. Pasture improvement costs the farmer money, and yet it is urgent for the economy that this work be done on a broad scale. An income-tax credit covering the initial costs of pasture improvement, such as the costs of land preparation, seeding, and fertilization, could serve as a powerful incentive for farmers to undertake this work, especially if this were supplemented by a payment for pasture improvement which the United States Department of Agriculture could make under its Agricultural Conservation Program if it had funds available.

Facilities for the handling of milk in dairies and dairy plants need to be improved and also expanded in order to handle the greater volume of milk that would become available by increasing production. Granting a reasonable income-tax credit on any such investments approved by the island's Secretary of Agriculture would provide a real incentive for buying new equipment and machinery and for modernizing dairy plants.

Any tax policy designed to encourage agricultural development obviously must be flexible enough to meet the needs of particular types of

enterprises. The guiding principles, however, should be the same. In the case of pineapples, for example, special consideration must be given to the kind of incentives required. This is because of the highly technical aspects of this particular industry and the big investments involved in growing, processing, and marketing this crop.

The pineapple industry in Puerto Rico could be developed into a major enterprise, but at the outset adequate facilities must exist for handling and processing the fruit. These are not now available for any reasonable expansion in acreage. To stimulate the investments necessary to increase production and to establish the essential facilities, tax incentives might well be made available to the industry. In the first place, any pineapple processor operating under Federal inspection should have his plant and equipment in the plant exempt from property taxes for a specified number of years. Secondly, income-tax credits should be made available for investments in new equipment, plant improvements, and for the establishment of new plant facilities, provided the plants operate under Federal inspection. The requirement that the plants must operate under Federal inspection in order to qualify for the tax incentives is designed to make sure that the facilities meet the standards necessary for producing quality products. Similar property tax exemptions for equipment used in growing pineapples and income-tax credits for the purchase of new equipment should be made available for farmers who produce this fruit.

The granting of tax exemptions on property used in the production and processing of pineapples will hardly be felt by the Puerto Rican till. The revenue on such property now employed in the industry is estimated at between \$5,000 and \$10,000. These tax exemptions would, however, have an important psychological effect in influencing desirable expansion in the pineapple industry.

Assistance of the same general type suggested for encouraging the pineapple industry could be made available for other fruits and vegetables that have good possibilities for development. The island lacks suitable central facilities such as warehouses and sheds for holding, grading, and packing fresh fruits and vegetables. Property tax exemptions extended to such facilities for a specified and limited period of time would result in no loss

of actual tax revenue to the local Government since such facilities do not now exist. Nevertheless, it would stimulate the establishment of the few that are needed for handling fresh produce.

Agricultural production on the island is hampered by a number of excise taxes which tend to restrict the output, distribution, and consumption of local farm products. Excise taxes are imposed on much of the machinery and equipment, as well as materials and supplies, used by farmers. The selling prices of these items are increased by from 5 to 15 percent (table 49), the selling price being defined by law as "the cost of production if locally produced or the cost of importation f. o. b. Puerto Rican docks, plus 20 percent." Excise taxes also increase the cost of fuels and lubricants used in agriculture and agricultural industries. Of course, a tax such as that imposed on gasoline and other motor fuels, brings in needed revenue that contributes to the construction and maintenance of necessary roads and highways. But

Table 49.—Excise taxes in Puerto Rico on farm machinery, equipment and other supplies, 1951

Item	Excise tax rate
Tractors.....	5 percent on selling price. ¹
Accessories and repair parts.....	15 percent on selling price.
Grass or silage cutters (electrically powered).....	Do.
Blowers.....	Do.
Refrigerators.....	Do.
Gasoline.....	8 cents per gallon.
Gas and diesel oil.....	4 cents per gallon.
Kerosene.....	3 cents per gallon.
Fuel oil.....	6½ cents per barrel of 42 gallons.
Lubricating grease.....	2 cents per pound.
Lubricating oil.....	1 cent per pound.
Fertilizers.....	15 cents per ton.
Soil amendments.....	10 cents per ton.
Cattle feed.....	20 cents per ton.
All automotive transportation vehicles (trucks, pickups, panels) except passenger cars.....	10 percent on selling price.
Hoists and cranes.....	5 percent on selling price.
Tires and inner tubes.....	15 percent on selling price.
Subsoilers.....	Free.
Plows.....	Do.
Harrows, rakes.....	Do.
Manure, lime spreaders.....	Do.
Insecticides, fungicides.....	Do.
Motors and all other equipment utilizing electric energy.....	15 percent on selling price.

¹ Selling price is defined by the Puerto Rican tax law as "the cost of production if locally produced or the cost of importation f. o. b. Puerto Rican docks, plus 20 percent."

where the fuel is used in farm tractors or in other farm motors that do not travel the public roads, the tax should not apply. Excise taxes boost the prices of all electric motors and any other equipment powered by electricity. The effect of this type of tax is to discourage the use of machinery and equipment which might help increase production and make it more efficient.

The excise taxes also tend to discourage the distribution and consumption of perishable farm products which are produced locally, especially those requiring refrigeration. In a tropical area the use of refrigerators definitely should be encouraged as a means of preventing food spoilage and waste. But this is not the case in Puerto Rico where the selling price is boosted 15 percent by the excise tax which adds considerably to the cost of an item already high because of substantial markups and transportation charges. The use of more refrigerating equipment should be encouraged in Puerto Rico as an aid to agricultural production and as a means of making more effective use of the available food supply. This is especially important to the dairy industry for unless proper refrigeration is available it is difficult to supply the consumer with quality milk. Also, more homes need refrigerators to store perishable foods such as milk and meats. This would widen the distribution of these foods and increase consumption, with benefit to the health of the people. The present lack of refrigerators greatly curtails the market for fresh milk and other locally produced perishables, to the detriment of both farmers and consumers. Removal of the excise tax on this item alone would be beneficial to the economy and the welfare of the people.

Action might well be taken to eliminate the tax which is assessed in January of each year on the value of stocks of raw sugar in Puerto Rico. This tax has been given as the reason why processors push raw sugar supplies on the market in the latter part of each year in order to avoid paying the tax. It would appear that elimination of this tax would offer an incentive for more orderly marketing and shipping of sugar during the last months of the year.

An item that gives rise to adverse pressure against agricultural resources is the tax of 3 cents a gallon on kerosene. This fuel is used for cooking in many rural and urban homes. The tax, however, increases the cost of this fuel to such an

extent that many more homes utilize wood and charcoal. Thus the pressure against an already virtually depleted forest resource is intensified when it should be eased and conservation encouraged.

From the standpoint of agricultural development, all excise taxes on production equipment and supplies should be removed along with those that tend to restrict the distribution and consumption of locally produced farm products. The

collection of some of these taxes obviously costs nearly as much as or more than the revenue obtained from them. Thus, it appears that the Puerto Rican Government would be more than compensated—out of the increases in economic activity and income that would stem from the expansion in the production and use of farm products that could thus be encouraged—for the removal of tax deterrents and for providing tax incentives where necessary.

Chapter XIII

Pulling Together for a Stronger Agriculture

Basic to the attainment of an improved standard of living for the people of Puerto Rico is the evolution of a new sense of custodianship over their land. This is the key to the kind of progress that will have to be made in the improvement and development of agriculture on the island. Since agriculture is and undoubtedly will continue to be the backbone of the island's economy, both rural and urban dwellers have a fundamental common interest in the welfare of this vital industry. How well the people can be served by their agriculture in the future depends on how much is done in the way of diversifying and expanding production, in improving distribution and marketing from the farm to the consumer, and in halting, through proper management and conservation, the island's great waste of its scarce natural resources.

But recognition of the common interest is not enough. It will have to be bound into a sort of partnership out of which can come the mutual encouragement and support that spur people on to determined action to reach a definite goal. The job that needs to be done to improve and develop the agriculture of the island is so great that there is room for all hands to participate in one way or another. The farmer, the worker, the housewife, the teacher, the clergyman, the banker, the businessman, the industrialist, and even the boy and girl in school—each has an important role to play and a contribution to make in this effort to build and conserve the agricultural resources of Puerto Rico. They all face an open challenge to participate in the enormous task which requires widespread cooperation and understanding to get it done and done well.

Government also has a responsibility and function in this task. It must be alert and responsive.

But unless the people on farms and in the towns and cities understand what the problems are in agriculture, how each segment of the population is affected by them, and unless each group has the initiative and is prepared to follow through with the necessary concerted actions, the Government by itself can accomplish very little.

Fortunately, Puerto Rico has governmental agencies, both Federal and local, capable of assuming the increased responsibilities and leadership which necessarily must be exerted in carrying out a comprehensive program for the island's agriculture. Lacking, however, is the thorough integration and high degree of coordination required for the execution of such program. Once there is general agreement on the overall objectives and the specific problems to be tackled in their order of priority, there should be no difficulty in embarking on a common course. But to get this done most effectively within the limitations imposed by the availability of funds, it will be necessary for each agency to redefine its own objectives and very firmly sift the really important from the half important in conformity with what may be required for concerted action.

The Federal and Puerto Rican Governments, between them, spend roughly 30 million dollars each year for the direct benefit of agriculture in Puerto Rico. Of this amount the United States Department of Agriculture alone spends nearly 25 million dollars, including payments under the Sugar Act that represent between two-thirds and three-fourths of this total. The total expenditure is exclusive of the several millions of dollars in loans made each year to Puerto Rican farmers and to their cooperative organizations by the Federal agricultural credit agencies. Puerto Rico shares along with the States in the programs,

services, and aids of the Federal Department of Agriculture. More than a million dollars a year is provided to help support agricultural extension work and research. Departmental activities such as those of the Forest Service, Agricultural Research Administration, Soil Conservation Service, Production and Marketing Administration (aside from Sugar Act payments), and the Federal Experiment Station involve nonrecoverable expenditures exceeding 3 million dollars annually. In addition, about 3 million dollars are made available in cash and in food donations for the operation of the school lunch program on the island, and this, as in the States, is for the benefit of both rural and urban communities. Altogether, the expenditures of the United States Department of Agriculture alone are at a level close to 28 million dollars a year in Puerto Rico (table 50).

For the various activities of its agricultural agencies, the Puerto Rican Government is also spending rather substantial sums in view of its restricted financial resources. In recent years this expenditure from locally appropriated funds has risen to as much as approximately 3½ million dollars just for the ordinary activities of only three agencies—the Puerto Rican Department of Agriculture, the Agricultural Extension Service, and the Agricultural Experiment Station (table 51).

A little more than two-thirds of this amount is spent by the local Department of Agriculture and the remainder by the other two agencies. Local funds for the Extension Service are somewhat more than \$400,000 a year. This is matched by more than \$600,000 in Federal allocations for extension work in Puerto Rico. Local funds for the Agricultural Experiment Station are slightly in excess of \$600,000, and the Federal contribution for the research activities of this agency amounts to a little more than \$250,000.

Both the Extension Service and the Experiment Station are under the jurisdiction of the University of Puerto Rico at Río Piedras. The university, at its College of Agriculture and Mechanic Arts at Mayagüez, maintains a School of Agriculture which offers a 4-year course of study leading to the degree of Bachelor of Science in Agriculture. While nominally linked to the School of Agriculture, the Extension Service and the Experiment Station operate independently except for the general supervision that is provided by the chancellor of the university.

Vocational training in agriculture is made available by the Puerto Rican Department of Education through courses in junior high schools and part-time and evening classes for young farmers and adults. Funds available for vocational agri-

Table 50.—U. S. Department of Agriculture expenditures in Puerto Rico, 1942–52^{1 2}

Fiscal year	Regular grants-in-aid for experiment station, extension work, and school lunch program	Other program expenditures—Sugar Act and agricultural conservation payments, rural rehabilitation and housing grants, and value of food commodities donated	Administrative and operating expenses of agencies with offices in Puerto Rico	Total
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
1942–43.....	304, 604	12, 139, 892	1, 128, 536	13, 573, 032
1943–44.....	2, 634, 412	14, 476, 667	2, 051, 632	19, 162, 711
1944–45.....	4, 101, 437	13, 647, 837	1, 925, 973	19, 675, 247
1945–46.....	1, 537, 267	13, 584, 332	2, 606, 218	17, 727, 817
1946–47.....	2, 802, 837	14, 170, 949	2, 441, 429	19, 415, 215
1947–48.....	2, 537, 811	15, 562, 556	1, 809, 254	19, 909, 621
1948–49.....	2, 850, 307	15, 741, 324	1, 900, 539	20, 492, 170
1949–50.....	3, 654, 083	19, 818, 351	2, 383, 147	25, 855, 581
1950–51.....	3, 714, 633	20, 865, 693	2, 391, 764	26, 972, 090
1951–52 ³	3, 785, 057	21, 062, 996	2, 496, 370	27, 344, 423
Total.....	27, 922, 448	161, 070, 597	21, 134, 862	210, 127, 907

¹ Data from Office of Budget and Finance, U. S. Department of Agriculture.

² Exclusive of loans.

³ Estimated.

Table 51.—Expenditures of Puerto Rican agricultural agencies, 1941–52

Fiscal year	Department of Agriculture	Extension Service ¹			Experiment Station ¹		
		Island funds	Federal funds	Total	Island funds	Federal funds	Total
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
1941–42.....	880, 663	145, 309	202, 170	347, 479	174, 543	100, 814	275, 357
1942–43.....	783, 954	181, 656	196, 648	378, 324	194, 636	99, 369	294, 005
1943–44.....	1, 630, 562	193, 665	281, 472	475, 137	204, 275	139, 456	343, 731
1944–45.....	633, 605	194, 667	340, 048	534, 715	201, 000	143, 213	344, 213
1945–46.....	1, 553, 992	271, 093	303, 128	574, 221	463, 286	147, 648	610, 934
1946–47.....	1, 698, 901	333, 743	243, 309	577, 052	483, 062	147, 648	630, 710
1947–48.....	2, 144, 585	345, 642	377, 295	732, 937	468, 986	181, 215	650, 201
1948–49.....	2, 278, 891	365, 007	521, 300	886, 307	537, 145	222, 447	759, 592
1949–50.....	2, 024, 192	391, 518	538, 897	930, 415	652, 750	248, 222	900, 972
1950–51.....	2, 424, 581	392, 319	611, 253	1, 003, 572	665, 282	255, 008	910, 290
1951–52 ²	2, 712, 679	477, 582	641, 321	1, 118, 903	605, 727	271, 985	877, 712
Total.....	18, 766, 605	3, 292, 201	4, 256, 841	7, 559, 062	4, 650, 692	1, 957, 025	6, 597, 717

¹ Exclusive of relatively small expenditures from Trust Fund.² Estimated.

cultural education have totaled about \$525,000 a year, of which about \$250,000 was federally contributed.

Thus with an overall annual expenditure of approximately 30 million dollars for the direct benefit of agriculture, it is apparent that both the Federal and Puerto Rican Governments have a substantial investment in that major industry of the island. Considering the tremendous stake that the people of Puerto Rico have in the improvement and development of their agricultural resources, it is evident that the desired objectives cannot be achieved unless every dollar available to any governmental agency for the benefit of agriculture on the island is made to return the fullest value. This calls for the utmost of cooperation from everyone concerned and requires that all of the agencies gear themselves to the needs of the big job that lies ahead.

But essentially the basic responsibility for moving forward with a comprehensive program for the island's agriculture must be a local one. The local people will have to set the pace. The agencies of the Puerto Rican Government with the Federal Government, especially those action agencies of the U. S. Department of Agriculture with operations in Puerto Rico, can then lend a very substantial helping hand in support of the whole effort. And in doing so, the programs of these Federal agencies will themselves prove more effective. The fact that the Federal agricultural agencies are keenly aware of both the problem and

the need gives heartening assurance that the necessary cooperation will be forthcoming to further the already good working relationships that exist between them and the insular agencies.

The Local Department of Agriculture

The key action agency of the Puerto Rican Government in the field of agriculture is its Department of Agriculture. This agency provides many services to farmers, and administers a number of programs for the improvement of agriculture and the enhancement of rural living conditions. Through its services the local Department of Agriculture safeguards the island's agriculture against the spread of plant and animal diseases and pests, administers tobacco production quotas, maintains quality standards for fertilizers, establishes grades and standards for farm products, provides inspection for fresh and processed fruits and vegetables, and carries on other similar service functions relating to the production and marketing of farm products. These include market news and crop reporting and statistical services which not only provide farmers with valuable information but also are of benefit to the buyers and consumers of agricultural commodities. The local Department of Agriculture also promotes the improvement and establishment of marketing facilities; it administers programs for the conservation of soil, water, and forest resources; provides crop insurance for coffee growers and administers a program for the rehabilitation of coffee produc-

tion; operates price control, price support, and agricultural credit programs; supervises and promotes rural cooperatives; encourages agricultural diversification and increased production; promotes farm ownership and rural settlement; operates sugar mills and farms that produce sugarcane and other crops; administers a livestock improvement program; and engages in a number of other activities of a similar nature.

In many respects the activities of the Puerto Rican Department of Agriculture are similar to those of the action agencies of the Federal Department of Agriculture which operate in Puerto Rico. Several of the programs and services are carried out on a joint basis under cooperative agreements between the Puerto Rican Department and the Federal agencies in order to centralize administrative responsibility, avoid duplication, and produce more effective results. This is particularly the case in the forestry work, the coffee rehabilitation program, fruit and vegetable inspection and grading services, and in livestock disease and pest eradication and control. Such a pattern of cooperative work relationships in which administrative responsibilities are more centralized could be profitably extended to some other Puerto Rican and Federal agricultural activities such as the farm ownership and soil conservation programs as well as the plant disease and insect control and quarantine work.

Moreover, there is need for establishing closer working arrangements among the insular agencies so as to clarify their respective spheres of activity as well as their basic responsibilities in relation to each other. Since the Puerto Rican Department of Agriculture is essentially an action agency, it necessarily requires help and cooperation from other supporting agencies such as the Experiment Station and the Extension Service in order that the most effective results may be derived from its programs. The Federal action agencies are in the same position. Both the Puerto Rican Department of Agriculture and the Federal action agencies, in working with farm people, must depend heavily on the kinds of assistance which these two are able to render in the fields of education and research in agriculture.

Through educational work of the Extension Service and research activities of the Experiment Station, farmers are assisted in developing their understanding and know-how and thus is formed

the solid foundation on which an action agency can proceed in carrying out its program. All must pull together in the same direction and at a pace that is related to the program requirements and the needs of the people with whom those administering the program must work.

In moving forward with a comprehensive agricultural program for the island, the supporting agencies will have to be in position to serve the varying educational and research needs of the action agencies. If the success of the overall program is to be assured, there can be no misunderstanding of the approaches to be taken and the objectives to be attained. Neither should there be any duplication of effort. All of the agencies concerned must be held accountable for the performance of their share of the work load. In order that responsibilities may be clearly defined, it would seem desirable for the Puerto Rican Department of Agriculture, as the key action agency, to enter into working agreements with such supporting agencies as the Extension Service and the Experiment Station. Such agreements could provide the framework for effective cooperative accomplishment and avoid possible misunderstandings which are bound to arise when reliance is placed solely on generalizations and informal procedures.

Strengthening Extension Work

Fundamentally, the Extension Service performs an educational function. In doing so it also develops rural leadership. The Extension Service provides the means through which pertinent information regarding the economic, scientific, technological, and other developments of significance are relayed to farm people and others in such form as to permit rapid application to everyday problems. It is the Federal Department of Agriculture's primary means of assisting farmers and homemakers to develop the know-how essential to successful modern living. This service, established on the island in 1934, is a cooperative activity as between the Federal and Puerto Rican Governments since it is supported with funds from each.

The Extension Service in Puerto Rico is not as well financed as it is in the various States. It never has received its complete share of the Federal funds authorized under the Bankhead-Flannigan Act which all States and Territories, except Puerto Rico, are receiving in full. The total amount authorized under this act for the Extension

sion Service of the island is needed and should be made available. While the island receives its proportionate share of the other Federal funds for agricultural extension work, the amount of money appropriated locally to match the Federal payments represents a smaller percentage than is provided for this activity in any of the other areas. For the fiscal year 1951-52, the Extension Service in Puerto Rico had a total of \$1,027,959, of which 62.4 percent represented federally supplied funds. By comparison, a breakdown of funds for extension activities in all States and other areas, including Puerto Rico, Hawaii, and Alaska, shows that 40.1 percent came from Federal payments and 59.9 percent from local appropriations.

The professional and technical staff of the Extension Service in Puerto Rico has the lowest pay-scale rates of any Extension Service within the United States and all its Territories. The average annual pay for county agents on the island in 1951 was \$2,914 compared with an average of \$4,904 for county agents in all States and Territories. Assistant county agents received an average of \$2,367 as against an average of \$3,802 for those in all areas. The pay for home demonstration agents in Puerto Rico averaged \$2,760 and for assistant home demonstration agents \$2,160. This compares with an average of \$3,864 for home demonstration agents and \$3,189 for assistant home demonstration agents for all States and Territories.

The conditions under which extension work is carried on in Puerto Rico are far more difficult than on the mainland. With 53,515 farms more than 3 *cuerdas* in size and with more than 51,000 holdings with less than 3 *cuerdas* of land, the Extension Service is always confronted with a big demand for its services, especially from the small farmers, who own 75 percent of the farms. These farms, however, contain only about 15 percent of the total land. The problem of working with rural families, most of them large and averaging 6 to 7 persons per family, is complicated by the high rate of illiteracy and the widespread lack of schooling that prevails in the country areas. Moreover, facilities for reaching these people are very poor. Many parts of the island where farmers live are inaccessible other than by foot or horseback. There are very few telephones in the rural sections and no rural mail delivery service. Many rural areas still have no electricity.



Many of Puerto Rico's towns and cities are rapid-growing centers of population and of business activity. For people in the urban areas a productive and prosperous agriculture on the Island is as important as it is for those in the rural sections.

Living under these many handicaps which make for virtual isolation, most of the farm people on the island are naturally conservative and skeptical. In order to overcome this drawback, extension workers have to spend a great deal of time in making personal visits with farm families to gain their confidence. The farm people on the island are generally reluctant to attend ordinary meetings, and the farm women rarely go to any such gatherings. Although some progress has been made by the Extension Service in overcoming this situation, it necessarily has been slow.

Lacking the required funds, the Extension Service is unable to build the staff needed for the scope of its work under conditions that prevail in Puerto Rico. The low salary scale makes it difficult for the agency to obtain qualified personnel and there is a continuing high rate of turnover in its technical and professional staff. As a result, extension work on the island reaches only about one-fifth of the farm families. The staff of agricultural and home demonstration agents totals around 160 men and women with about 60 specialists, supervisors, and other administrative officers. The number of agricultural and home demonstration agents would have to be increased substantially and additional specialists provided to enable this

agency to carry on a reasonably adequate extension program that would attempt to reach a majority of the rural people. This would approximate a 30 percent increase in the professional and technical staff.

Although laboring against many serious handicaps, the Extension Service in Puerto Rico has, since its establishment in 1934, made some outstanding contributions to the welfare of rural residents. But it has had relatively little impact on the overall agriculture of the island. The agency has spread itself out over a wide field of extension work without first having the necessary number of qualified personnel for the size of staff required in a program of such broad scope. But starting from a point where there was no such educational service for rural people, it has been able to obtain many good results from the work done.

The fact that agricultural extension work on the island aims to encompass so much while lacking the necessary resources with which to do a thorough job under unusually difficult conditions, stems largely from the attempt to emulate extension work in the States. The mainland pattern of agricultural extension activity is specialized to meet conditions in the States. Custom and tradition deeply ingrained in rural people must be taken into account in shaping extension work to Puerto Rican needs. In view of all the limitations that have to be faced, including the lack of necessary funds and personnel, extension work in Puerto Rico probably would be more far-reaching in its total effect on the people and the economy if its scope were narrowed for a time to a few of the more fundamental needs. It is in this light that the present program of the Extension Service on the island should be reexamined and reevaluated in order that the work of its agents may result in the greatest good for the greatest number of people in terms of production and human welfare.

The Extension Service is the one agency in Puerto Rico basically responsible for out-of-school educational work with rural families and homemakers in the fields of agriculture and home economics. A lack of recognition as such has been manifest in recent years by the establishment of new agencies and services and the annual appropriation of Puerto Rican funds to them for programs and activities which really should be the responsibility of the Extension Service. This has

given rise to unnecessary competition for the attention of rural people and results in duplication and a wasteful dispersion of effort and money. With a proper allocation of funds, the Extension Service could equip itself to handle all such work that is within its scope of activity and serve as a supporting medium for these other agencies. Working agreements between the Extension Service and each of the agencies being served would insure against any misunderstandings as to the job to be done and the goals to be attained. Such arrangements could be profitably employed between the Extension Service and two agencies in particular—the Division of Community Education of the Department of Education and the Social Programs Administration of the Puerto Rican Department of Agriculture.

The Division of Community Education aims to encourage cooperative action on the part of the people of the island with the purpose of self-improvement and of improvement of living and working conditions. Through a staff of group organizers, educational meetings are held in communities and the local people are encouraged to discuss, plan, and find solutions to their problems on a self-help basis. In some respects this duplicates extension work. The Extension Service can assist in this community education program by providing valuable guidance in the consideration and solution of agricultural and homemaking problems which the group organizers usually encounter in the rural communities. A closer integration of the community education and agricultural extension programs in rural areas and improved cooperative relationships between the two agencies would increase the value of these activities to the people.

The Social Programs Administration also has a series of programs designed to promote adult education and encourage group action. To the extent that the work of this agency involves extension activities in agriculture and home economics, it duplicates the proper functions of the Extension Service. Such of the activities of the Social Programs Administration as are in the field of the Extension Service could be turned over to that agency under an agreement that may be developed between them to center responsibility for adequate performance of the work.

One of the big opportunities for reaching large concentrations of rural people to help them with

their problems is in the more than 180 rural communities developed by the Social Programs Administration under its rural resettlement program authorized by Title V of the Land Law. Each of these communities has from 100 to 500 farm laborer families, with each family having under its control from one-fourth to three *cuerdas* of land for a home and the production of some subsistence crops. The present low standard of living of these families could be improved materially with the right kind of help and guidance in food production and homemaking such as the Extension Service is capable of providing.

The full time assignment by the Extension Service of an agricultural agent and a home demonstration agent to every four or five of these rural communities would represent a wise expenditure of funds, especially when measured in terms of the increased real income which these rural families could be taught to attain for themselves from their own land and with their own hands. The agricultural agent could work with each family in obtaining the best use of the plot of land available to it for food production. This would involve helping each family to develop a food production plan directly related to the land available and the size of the individual family, and providing the necessary advice, guidance, and follow-through that would be required in working with these people. The home demonstration agent's function would be to work with the women in community canning, health, nutrition, and the various homemaking activities. Of course 4-H Club work for boys and girls would also be involved in the activities of the extension agents. Considering the little on which these rural families have to live, the help and education that could be derived by them from such an undertaking by the Extension Service would make a very substantial and lasting contribution to their well-being.

The Extension Service, of course, cannot be considered as having a monopoly in the field of informal education in agriculture and home economics. But since this kind of work is its basic function, it is desirable that the educational phases of the activities of all agencies concerned with the rural and agricultural welfare be coordinated and, insofar as possible, executed through the Extension Service. The educational and advisory nature of the Extension Service must be kept in

mind in the planning and operation of any program directly affecting agriculture and rural people.

The Experiment Station's Role

Progress in agriculture is heavily dependent on research and experimentation. The results of this investigational work provide the information and know-how required for enlightened and effective action. In Puerto Rico, as in the States, the Agricultural Experiment Station carries on a research program aimed at the solution of all types of problems confronting the local agricultural industry. With its staff of more than a hundred highly trained scientific specialists, this experimental station has made some notable contributions toward the preservation and improvement of agriculture on the island. In sugarcane alone, its introduction, breeding, and testing work has resulted in improved and disease-resistant varieties which if planted throughout the island could easily increase sugar production by 15 percent or more.

The broad scope of the Experiment Station's work includes (1) economic and sociological investigations, including studies of production costs, factors affecting commodity prices, efficiency of labor utilization, farm organization and social status of farm families; (2) marketing investigations, including proposals for improvement of facilities for the handling and marketing of agricultural products, and expanding market outlets; (3) crop and livestock improvement by the introduction of new plants and animals and through breeding and selection; (4) control of diseases, insects, and parasites affecting plants and livestock; (5) animal feeding and nutrition investigations; (6) studies of fertilizer requirements for crops, including both major and minor plant nutrients; (7) studies of human nutrition and the nutritive value of locally produced foods; and (8) development of improved and new uses for local farm products and byproducts.

Like the Extension Service, the Experiment Station represents a cooperative activity as between the Federal and Puerto Rican Governments and it is supported by funds from each of these sources. The fundamental research and experimental work of the Experiment Station is often conducted in cooperation with agencies of the United States Department of Agriculture. Where-



This rural grocery store, like so many others in areas distant from Puerto Rican towns, serves as a collection center for farm products to be picked up by truckers and hauled to market. The cases being carried contain eggs packed with dried leaves as a protection against breakage.

ever possible the resulting scientific and technical knowledge is employed in their agricultural programs. The Extension Service relies heavily on the Experiment Station for information which when brought to the farmers can be converted into practice.

Even though the Puerto Rican Government has supplied in some years more than two and one-half times the amount of money allocated by the Federal Government, the total funds available to the Experiment Station cannot cover the many and varied needs for agricultural research on the island. There remain untouched many major problems which should be studied to develop essential information and necessary solutions. The great diversity of research and experimental work in which the Experiment Station is engaged suggests the need for a reevaluation of its program. In view of the limited funds available to the Experiment Station, expenditures for research and experimentation in Puerto Rico have to be governed primarily by the relative importance of each project and the contribution which the economy may derive from the possible results. This agency's work obviously must be closely geared to the urgent requirements of a comprehensive agricultural program for the island.

Basically, the Experiment Station is a supporting agency especially equipped with staff and facilities for scientific and other highly technical work. By the very nature of its authorizations, both under Federal and Puerto Rican laws, the Experiment Station has prime responsibility for research and experimentation in the agricultural field. The fact is, however, that in Puerto Rico several of the agencies of the local Government are engaged in agricultural research in addition to their regular activities and independently of the work done at the Experiment Station. Some of these agencies have such broad legal authorizations that there is no limit on the kind of research in which they may engage.

The Economic Development Administration, for example, is carrying on considerable research in the utilization of molasses and other byproducts from sugarcane. It operates a pilot plant for the production of yeast and maintains laboratories where research projects are under way on yeast, citric acid, glucose derivatives, and the utilization of bagasse.

Another action agency, the Puerto Rican Department of Agriculture, also conducts extensive independent research in a wide field. Through its various units this Department has engaged in re-

search in pineapple and sugarcane production, livestock breeding and raising, and the manufacture of such items as candies, jellies, ice cream, and pineapple products. Research is conducted in the fields of economics, marketing, and cooperatives.

The College of Natural Sciences of the University of Puerto Rico has engaged in research covering such products as alcohol and citric acid, and made ontogenetic studies of *Carica Papaya* and studies of protein in foods. In another branch of the university at the College of Agriculture and Mechanic Arts, agricultural research has been conducted independently on plant fertilizers, grasses and legumes, sugarcane varieties, sweet-potatoes, vanilla, vegetables, breadfruit, ornamental plants, breeds of chickens, dairy cattle, and others.

All of these governmental agencies work in the field of agricultural research independently and on their own account. Although an effort may be made at avoiding duplication, it is not always successful. Moreover, the different projects do not represent an integrated plan of agricultural research. They are carried on merely as incidental sidelines to the regular and more important functions for which these agencies were established.

A sounder and more economical procedure would be to have a single agency recognized as being in general charge of agricultural research, with other agencies participating to the extent desirable in cooperative projects developed as parts of a well integrated research program. In this way it would be possible to avoid duplication of effort and make the best use of existing facilities and the trained personnel available. Funds available for agricultural research would thus return more value for each dollar spent.

The Experiment Station with its highly qualified staff is fully capable of performing the necessary coordinating functions and of providing the leadership needed for an effective agricultural research program that will deal with fundamentally important problems and make the greatest contribution to the well-being of the economy. In carrying out its responsibilities in cooperation with other agencies, it needs to guide local agricultural research policy and serve as a clearing house in approving and integrating all agricultural research work that may be undertaken by

any other Puerto Rican agency. In order to avoid costly diffusion and duplication, it appears desirable to have research work consolidated and responsibility for it centralized wherever possible.

On the other hand, the Experiment Station should not direct programs or activities which are outside of its recognized sphere of work as a research agency. Specifically, the seed farms which it operates are essentially action and service functions beyond the field of research. These functions more properly belong to an action agency such as the Puerto Rican Department of Agriculture to which they should be transferred. Functioning under such a change in jurisdiction, the seed farms should produce for commercial distribution to farmers only those strains and varieties of seed and plant stock tested and recommended by the Experiment Station.

Formal Education in Agriculture

One of the big handicaps in the development of agriculture in Puerto Rico is the lack of education among so many people in the rural areas. The 1950 census shows that 29 percent of the rural people are unable to read and write, as compared with 17 percent in the urban section. Almost one-half the children 5 to 13 years old in rural areas are not enrolled in school, against a little more than one-third in the urban centers. More than four-fifths of the rural people are unable to speak English as compared with about three-fifths in the urban sections. Yet looking back at what the level of educational attainment was only a couple of decades ago, it is clear that the island has been making substantial progress despite the growth of its population. Illiteracy, however, is still too high for a modern economy. The island will have to continue to strengthen its educational effort, and in doing so give special emphasis to the needs of the rural areas where the lack of education is greatest.

The equivalent of a little more than one-fourth of the Government of Puerto Rico's budget is spent for education, including operation of the school-lunch and milk-station programs. This represented about \$34,500,000 in 1951-52, and included \$6,276,000 for the University of Puerto Rico, \$4,455,000 for school-lunch and milk-station programs, \$1,323,000 for vocational education, \$2,364,710 for capital improvements in the public

school system, about \$16,500,000 for teacher salaries and incidental operating expenses, and slightly more than \$1,800,000 for general administrative costs. Exclusive of funds for the university and for capital improvements, the amount available in 1951-52 to cover educational costs and the operation of the school-lunch and milk-station programs totaled slightly more than \$25,800,000. Of this amount, only 38 percent was allocated to the rural areas. Of the \$16,500,000 (included in this \$25,800,000) to cover teacher salaries and incidental operating expenses, the rural areas received only 42 percent. In view of the fact that the number of children under 14 years of age in rural areas is almost twice the total of such children in urban sections, it is evident how meagerly the bare educational needs of the country people are being met. In this field of education, the highest priority should be given in the years immediately ahead to the improvement and extension of elementary schooling for children in the rural areas.

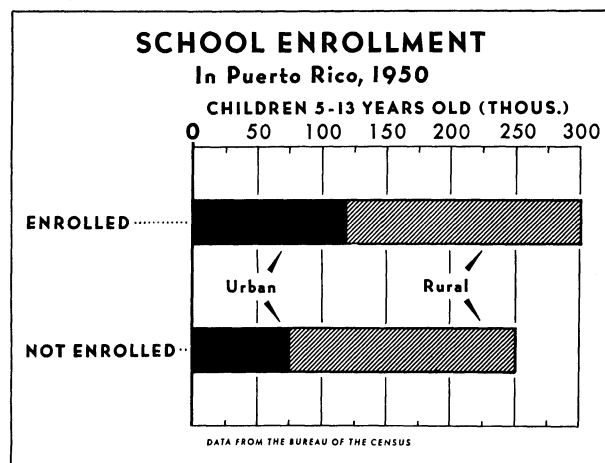
In the sphere of higher education, the College of Agriculture and Mechanic Arts at Mayagüez is the principal facility on the island for the training of agricultural leaders, scientists, technicians, extension workers, and vocational agricultural teachers. Although a part of the University of Puerto Rico at Río Piedras, this institution is operated as a separate entity under the general su-

pervision of the chancellor of the university who serves as the main connecting link between the two. A vice chancellor serves as the principal administrative officer at the Mayagüez institution.

The College of Agriculture and Mechanic Arts has four instructional divisions: the Division of General Studies, and the Schools of Agriculture, of Engineering, and of Science. The Division of General Studies serves all of the students in the various schools during their first two years by providing basic courses prior to specialization in a major. This division comprises the six basic courses in biological sciences, English, the humanities, physical sciences, social studies, and Spanish, and other cultural courses. The total annual enrollment at this institution has averaged somewhat greater than 1,000 students during the 5 years following the end of World War II. The campus covers 38 acres and the college has about 178 acres in farmland.

The university has at Río Piedras the Colleges of Humanities, Natural Sciences, Social Sciences, Business Administration, Education, Law, Pharmacy, the Division of General Studies, the Agricultural Experiment Station, and the Agricultural Extension Service. In nearby San Juan is located the new School of Medicine and the School of Tropical Medicine. The university campus at Río Piedras comprises about 288 acres and the regular enrollment averages a little greater than 5,000 students. Teaching, research, and recreational facilities are available for all kinds of student interests and activities.

Located as it is more than 100 miles from its parent institution, the College of Agriculture and Mechanic Arts cannot avail itself of the highly diversified large staff and the extensive facilities available at the university in Río Piedras. This is a great disadvantage to the students at Mayagüez since they do not have the same educational opportunities and advantages that are open to the other students. The desirability of transferring the educational work from Mayagüez and integrating it with the university at Río Piedras has been considered from time to time, but always has encountered local opposition from people in Mayagüez who did not want to lose the institution. Certainly if the teaching work at the institution should be moved, some other good use could be found for the buildings and other facilities.



The rural areas of Puerto Rico not only have the most children but also a smaller proportion of them enrolled in school compared with those in urban sections. Of the total number of children 5 to 13 years old on the island, the 1950 census showed that only about one-half of those in rural areas were enrolled in school as against three-fifths of those in urban centers.

From the standpoint of the taxpayers of the island it is costly to maintain two separate educational plants that otherwise could be integrated in order to serve the educational needs more adequately. Pending the time when the people themselves decide on a different course, the only alternative is to make the best of the existing situation.

The School of Agriculture at the College of Agriculture and Mechanic Arts, in its 4-year curriculum leading to the degree of bachelor of science in agriculture, aims to provide training of a general nature as a preparation for farming, agricultural extension and teaching, or for other occupations calling for training in agriculture. The enrollment during the 5 years following World War II has averaged approximately 275 students a year, which is somewhat less than for the years immediately preceding the war.

In general, the School of Agriculture is fairly well equipped with laboratories and other physical facilities required for the teaching work. The agricultural teaching staff, however, is relatively small, totaling only 26 in 1951-52, but the enrollment is also small. An analysis of the courses offered to the students majoring in the School of Agriculture indicates that there is great emphasis on specialized and applied subjects, an emphasis more characteristic of a vocational school than of an educational institution that attempts to prepare students for agricultural leadership.

In fact, the greatest contribution that the School of Agriculture could make to the economy of Puerto Rico is in the development of students who could become good leaders in the agriculture of the island. Puerto Rico very much needs a greatly increased number of individuals trained for agricultural leadership. If the number and kind of leaders required in the agriculture of Puerto Rico are to become available, they will have to be developed by the island itself. For unlike any State and largely because of the language difficulty, Puerto Rico cannot easily attract trained personnel from many other parts of the United States.

The teaching program of the School of Agriculture needs to be geared more closely to the varied realistic requirements of the island, and these needs command primary concern. This obviously necessitates some reorientation and the evolution of a truer and more fundamental perspective of the school's functions and responsibilities as an

educational unit serving the interests and requirements of the island's agricultural industry and its people. The needs and objectives to be met should first be determined, and then a decision made as to what can be done to satisfy the wants and attain the desired goals.

Serving on a team with the Department of Agriculture, the Extension Service, the Experiment Station, and other agricultural agencies on the island, the School of Agriculture holds the place of an active participant in meeting the needs of farm people and their problems. In this position, its program has to be so designed as to serve in inspiring students to enter any of the many branches of agriculture as a profession, realizing that there is far more to agriculture than the operation of a farm and tilling the soil. Its teaching work needs to be such as to provide students with a broad foundation of fundamental knowledge required in modern agriculture and also train them for responsible leadership. Moreover, the School of Agriculture has an opportunity to serve as a major focal point for the agriculture of the island and to open its facilities and services for meetings and provide needed short courses that will extend training to all who may seek it.

Any and all methods that can be devised to improve the School of Agriculture's service deserve to be cultivated. At present the school is admitting small classes of students who have not had the benefit of adequate high school preparation and offering them a complex array of courses. The main problems of the institution divide themselves into those of students and curriculum.

Most of the students attending the School of Agriculture come from rural areas and only a few from urban sections. The small total enrollment is indicative of a lack of interest in and understanding of agriculture and its opportunities among prospective students. The School of Agriculture could develop a greater interest in agriculture as a profession by taking pains to carry its message to the high schools and through the medium of addresses, programs, and literature present this industry in its true light as an important and honorable calling which offers a challenge to the individual's intelligence.

Besides being hard to recruit, many of the students coming from the rural areas are poorly prepared in the academic subjects required as a basis for college work. Entrance requirements for

the School of Agriculture are as rigid as the general requirements of the College of Agriculture and Mechanic Arts. There might be a little more leeway in them but still they need to be adequate for purposes of the school itself.

Some means should be devised for improving the preparation of students for college entrance. The Puerto Rican Department of Education could assist by strengthening the high-school teaching staffs or the instruction in certain of the weakest areas. Also, the college could offer a special summer session for a short time before the opening of the freshman semester in order that prospective students who need to may catch up on some of the required studies. Another alternative would be to offer special college coaching sections during the first semester for students who are deficient.

Many of the prospective students as well as those already attending college come from families of very limited income. They cannot afford the cost of boarding in Mayagüez. If possible, some means of economic assistance might be offered by the granting of competitive scholarships to students from country high schools. Such a scholarship would help offset the cost of living away from home. The establishment of a scholarship fund to which private agricultural and business interests may contribute along with the Puerto Rican Government could be encouraged for the purpose of helping rural young people to obtain education from which the entire economy might be expected to benefit in the long run.

On the curriculum side, the present teaching program of the School of Agriculture is stretched out over too wide a field for the restricted size of the staff and the small number of students. It lacks a simple, concentrated objective which should be a broad, thorough grounding for work and leadership in agriculture. Instead, the emphasis is on the molding of subject matter specialists with relatively little emphasis on developing the potentialities and the outlook of the individual student. The needs of the island would be more adequately served if the teaching program of the School of Agriculture gave uppermost attention to the economic and social problems of agriculture on the island and if it provided a broad general training and educational foundation so that its graduates would be at home as workers and leaders in any phase of agricultural or any related

activity. Of course, some specialization is desirable. But this need not preclude a good distribution of courses to provide a strong background of preparation in such subjects as economics (including production, distribution, marketing, cooperatives, and credit), English, public speaking, sociology, and the sciences. Several of the detailed subject matter courses profitably could be telescoped and thus made available to more students. With such a program all students would be graduated with a common and strong background of preparation, regardless of the subjects in which they may have majored. On such a foundation each graduate would then be able to build his own life work. This would be a simpler program, easier to staff and administer, and less expensive to operate.

Many of those who for one reason or another do not attend college could, however, take advantage of additional educational opportunities if these were available and were not too time-consuming or costly. And among those who do attend college, there are some who are interested only in specialized subjects that would help them in their vocation. To meet these needs among people interested in agriculture, the School of Agriculture might well consider establishment of a series of adult short courses in specialized fields, including 1-year and 2-year courses to provide vocational and technical education especially for rural boys who plan to engage in agriculture. The 1-year and 2-year courses could place major emphasis on what, when, and how to do the jobs which are required of farmers and others engaged in agricultural pursuits. Some general training could be given in basic sciences and in Spanish, English, economics, and government but the students would receive less training than is required for a degree in the School of Agriculture. The adult short courses probably would be of various lengths, from a few days to a few weeks, depending upon the particular subject. Through the medium of such courses the special educational needs of farmers and others who want to be brought up to date on specialized agricultural subjects could be satisfied and both the individuals and the economy would profit.

The short courses which the School of Agriculture could provide would be a valuable supplement to the vocational training in agriculture be-



The use of tractors is gradually increasing in Puerto Rico. Most of those now employed are built for heavy plowing and other such work on large farms, especially sugarcane plantations. More of the lighter all-purpose tractors such as the one shown could be used advantageously on many of the diversified and other smaller farms.

ing made available by the Puerto Rican Department of Education. The vocational work of the Department of Education affords an opportunity for systematic instruction in agricultural subjects. The teaching activities are conducted through the combined means of classroom instruction and supervised farming on the farms of the students enrolled in the agricultural courses of junior high schools or in part-time or evening classes for young and adult farmers. This is a type of formal education which deserves to be extended so that it could be offered more widely on the island. For example, vocational agricultural instruction might well be made available in selected high schools so as to reach students who are older than those enrolled in the junior high schools. If sufficient local funds were made available to match the Federal allocation so that matching funds now appropriated would not have to be used for unmatchable items (such as the purchase of seeds, fertilizers,

pay for caretakers, etc.), it is believed that vocational agricultural instruction could be provided in about 15 high schools located in the central part of the island. In addition, it would be possible to improve and expand this agricultural teaching work so as to reach more young and adult farmers in rural areas where such instruction is greatly needed.

A clear definition of the role of vocational agricultural education and that of extension work is desirable so as to avoid duplication of effort in the communities. Close working relationships between vocational instructors and extension workers need to exist without any encroachment (real or imagined) in each other's recognized spheres of activity in the same community. In view of this it would be desirable for the Extension Service and the Department of Education to develop a working agreement to clarify their respective responsibilities in the formal and informal fields of

education in agriculture, and thus provide a firmer basis for effective cooperation between the representatives of the two agencies.

Overall Program Needs

The successful administration and operation of a comprehensive program for the development of agriculture in Puerto Rico requires full and effective cooperation from all participants and proper coordination and integration of all of the measures and efforts to be employed. The various governmental agencies have especially important roles to play in their respective spheres of activity. Regardless of what may be the special function of any agency, all agencies need to pull together in a like direction and with the same high degree of determination to reach the common objective. The interdependence that such an effort requires calls for a mutuality of understanding and confidence in each other.

To provide a means for the interagency coordination required by such a program, it would seem desirable that there be established by the Governor of Puerto Rico, in cooperation with the United States Secretary of Agriculture, an Agricultural Development Council on which the heads of the various respective local Federal and Puerto Rican agencies directly concerned with the agriculture of the island are designated to serve. Since the Puerto Rican Department of Agriculture is the key action agency of the local Government in the field of agriculture, the island's Secretary of Agriculture probably should be designated as chairman and serve as leader of the group.

The function of the Agricultural Development Council would be to do the overall planning and policy-making required in carrying out the many phases of a comprehensive program. Through its deliberations the council would determine an order of priorities for the different actions to be taken, and assign specific responsibilities for performance of the work required to be done by the various agencies. As a coordinating medium, the council would insure the necessary collaboration among agencies and would serve to cement working relationships among them.

Among the agricultural agencies of the Puerto Rican Government, a closer integration of the Extension Service, the School of Agriculture, and the Experiment Station appears desirable. Operating as they do independently of each other,

each is handicapped by the lack of common appraisal of problems to be met and joint planning of the educational and research programs that are carried out. Each agency functions on its own, often without regard to the specific needs of others or what is being done by them.

The three heads of these agencies are under the general supervision of the chancellor of the university to whom they report directly. The chancellor's office recognizes the necessity for coordination and has undertaken to provide it, but among the agencies themselves there is need for centralizing the policy-making functions, centering responsibility, and providing more direct and effective supervision over the development and execution of the respective programs so that they form integral parts of a whole.

One suggested way for eliminating the existing diffusion would be to vest the authorities and responsibilities of the present heads of the three agencies in one highly capable and qualified individual who would be designated as director of the Extension Service and also of the Experiment Station and dean of the School of Agriculture. Then the Extension Service and the Experiment Station could each have an associate director and the School of Agriculture an associate dean, and these officials would be responsible for the day-to-day operations of their respective agencies. In effect, they would constitute an administrative team working under the coordinating direction of one policy-making officer who would report directly to the chancellor. Such a modification deserves consideration. It could increase the efficiency and effectiveness of operations and provide the basis for greatly improving the educational and research services to the island's agriculture.

But irrespective of what any or all of the governmental agencies may do, the success of a program for agriculture has to be measured against what is actually accomplished on the land and among the people themselves. Without the necessary cooperation from farmers and others, little progress can be made. But if people are to cooperate they must have an understanding of purposes and objectives and need, also, the leadership that will guide and inspire them into action.

Experience in working with rural people has demonstrated that the best and most effective kind of leadership is that which comes from among the

people themselves in their own communities. It is such rural leadership that makes it possible to organize for action from the bottom up. Such is the leadership that must be found. Where it is lacking, there is need to develop it.

Many of the agencies are already working with rural leaders and have farmer committees functioning in connection with their individual programs. All of these can serve and contribute to the broad effort. They form a strong nucleus for concerted action in the attainment of a common goal. But they will not be enough for the gigantic task that lies ahead. Every resource of local farmer leadership will have to be enlisted to supplement the efforts and the work of all the governmental agencies and their workers.

What is contemplated in the improvement and development of the agriculture of Puerto Rico

cannot be achieved by the simple wave of a magician's wand. It will take much time and effort and will require all of the courage and positive action that the people of Puerto Rico are capable of exerting. The execution of such a comprehensive program for the agriculture of the island will take inspired leadership plus ingenuity among those whose job it is to work with farmers and others. It will take widespread public understanding and support. But above all, fulfillment of the program will require grim determination and much hard work on the part of the farmers themselves. The opportunity to combine forces in the realization of the goals for agricultural improvement and development never has been greater in Puerto Rico. This opportunity to reach a common objective so vital to the permanent economic strength of the island is a challenge to everyone who has a stake in Puerto Rico's future.

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Index

	Page		Page
Agencies, agricultural, expenditures, 1941-52.....	273	Beef—	
<i>Agregados</i> , resettlement.....	251, 258	price and value, 1950-51 and proposed.....	216
Agricultural—		production—	
credit. <i>See</i> Credit, agricultural.		price and value, 1950-51.....	182, 184
finance and credit.....	151-174	proposed.....	195
production, potentials.....	175-218	Beets, production, proposed.....	195
Agricultural Conservation Program, payments.....	97	Beverages, imported, volume and value, 1950-51..	185
Agricultural Development Council, proposed.....	284	Bibliography.....	287-290
Agricultural Marketing Agreement Act of 1937....	233	Birth control.....	25-26
Agriculture—		Birth rates.....	7-8
balance, improvement.....	190-214	Breadfruit—	
development, overall program.....	283-285	area, production, and yield, 1950-51.....	194
diversified, need.....	143, 144, 188-189, 190	production, price, and value, 1950-51.....	182
effect of tax policy.....	262-269	Broilers, production, commercial.....	214
formal education in.....	279-283	Business expansion.....	43-44
improved, goals.....	271-285		
present pattern.....	181-184	Cabbage—	
role in economy.....	31-32	area, production, and yield, 1950-51.....	194
Alcohol production from molasses, research.....	229	price and value, 1950-51 and proposed.....	216
Aqueduct and Sewer Authority, operation.....	83-84,	production—	
	86, 89, 92, 93, 94	price and value, 1950-51.....	182
Aqueduct districts—		proposed.....	195
population, 1940, 1950.....	83, 84	Canals—	
water output, 1950-51.....	84	drainage, facilities.....	141
water supply.....	84	Isabela Irrigation Service.....	71
Aqueducts, rural, construction, costs.....	86-87	South Coast Irrigation District.....	68-69
Arecibo River coastal area, irrigation project....	72	water losses.....	74
Avocados—		Caonillas Reservoir, completion.....	56
culture.....	199	Carite hydroelectric plants.....	70, 78
price and value, 1950-51 and proposed.....	216	Carite Reservoir, storage capacity.....	67
production—		Carrots, production, proposed.....	195
area and yield, 1950-51.....	194	Cassava—	
price, and value, 1950-51.....	182	area, production, and yield, 1950-51.....	194
proposed.....	195	culture.....	203
		price and value, 1950-51 and proposed.....	216
Bagasse utilization.....	240	production—	
Bananas—		price and value, 1950-51.....	182
area, 1949.....	35	proposed.....	195, 203
area, production, and yield, 1950-51.....	194	<i>Centrals</i> —	
culture.....	203-204	farm holdings.....	152
price and value, 1950-51 and proposed.....	216	labor exploitation.....	38
production—		loans for credit.....	151, 157, 158, 159, 160
price and value, 1950-51.....	181, 182	operations.....	235-236, 239, 252, 254-255
proposed.....	195	purchases by Puerto Rico Reconstruction	
Bank for Cooperatives.....	157, 166-167	Administration.....	249
Banking institutions.....	151-153, 157	use of water on cane land.....	74
Beach erosion, problem.....	58	water requirements.....	88-89
Beans, dry—		Cereals—	
area, production, and yield, 1950-51.....	194	culture.....	205-207
culture.....	207	production, price, and value, 1950-51.....	182, 183
imported, value, 1950-51.....	186	requirements and supply, 1950-51.....	187
price and value, 1950-51 and proposed.....	216	Charcoal, production, price, and value, 1950-51..	182, 184
production—		Cibuco River coastal area, irrigation project....	72
price and value, 1950-51.....	182	Citrons—	
proposed.....	195, 207	area, production, and yield, 1950-51.....	194, 200
		price and value, 1950-51 and proposed.....	216

	Page		Page
Citrons—Continued		Cooperative—	
production—		agreements.....	226, 274
price and value, 1950-51.....	182	<i>See also</i> Working agreements.	
proposed.....	195, 200	buying, fertilizers.....	166
Citrus fruits—		loans, sugarcane.....	161, 166
requirements and supply, 1950-51.....	187	marketing—	
<i>See also</i> Grapefruit; oranges.		cotton.....	164
Climate.....	3-4, 31	tobacco.....	159-160
Coamo irrigation project.....	146-148	Cooperatives—	
Coamo Reservoir—		agricultural.....	226
sedimentation.....	54-55, 56	Bank for.....	157, 166-167
storage capacity.....	67	consumers', rural.....	21
Coamo-Baute irrigation project.....	72	credit.....	161, 166
Coconuts—		farm, proposed.....	261-262
area—		sugarcane, proposed.....	262
1949.....	35	Corn—	
owned by Land Authority, 1952.....	253	area, 1949.....	35
production, and yield, 1950-51.....	194	area, production, and yield, 1950-51.....	194
culture.....	200	culture.....	205-206
land in proportional-profit farms, 1952.....	254	feed, imported, volume and value, 1950-51....	185
price and value, 1950-51 and proposed.....	216	price and value, 1950-51 and proposed.....	216
production—		production—	
price and value, 1950-51.....	182	and value, Lajas Valley.....	140
proposed.....	195	price and value, 1950-51.....	182
Coffee—		proposed.....	195, 206
area—		Cotton—	
1949.....	35	area, 1949.....	35
non-productive, 1950-51.....	194	area, production, and yield, 1950-51.....	194
production, and yield, 1950-51.....	194	culture.....	208-209
crop insurance.....	168-170	marketing, cooperatives.....	164
culture.....	197	price and value, 1950-51 and proposed.....	216
exports, 1828-62.....	28	production—	
growing on forest lands.....	104, 116	price and value, 1950-51.....	182, 184
industry.....	31, 36, 42	proposed.....	195, 208-209
loans.....	158-160, 161-162	status.....	164
price and value, 1950-51 and proposed.....	216	Cotton Growers Marketing Cooperative Associa-	
production—		tion.....	164
improvements.....	180, 197	Cottonseed, imported, volume and value, 1950-51..	185
price and value, 1950-51.....	181, 182	Cowpeas—	
proposed.....	195, 197	area, production, and yield, 1950-51.....	194
research need.....	64, 109-111	price and value, 1950-51 and proposed.....	216
yields.....	64, 109-111	production—	
College of Agriculture and Mechanic Arts.....	134, 171, 280-282	price, and value, 1950-51.....	182
Colonos, sources of credit.....	158, 159	proposed.....	195, 208
Comerio Extension Project.....	72	Credit, agricultural—	
Comerio Reservoir, sedimentation.....	54-56	and finance.....	151-174
Commission for the Control of the Bodies of Water		costs.....	158-160
in Puerto Rico.....	91	education and supervision.....	170-172
Commodities, selected, price and value, 1950-51,		legal obstacles.....	172-174
and proposed.....	216	requirements.....	160-164
Commodity Credit Corporation—		sources.....	164-170
loans.....	156-157	Crop—	
sugar purchases, 1942-47.....	40	insurance programs.....	168-170
Communication services, inadequacy.....	20, 227	lien law, limitations.....	174
Conservation—		production—	
education.....	61-63	loans.....	157-158
fishery and wildlife.....	102	proposed pattern.....	214-218
research, basic.....	63-64	Cropping, double, advantages.....	193
Containers, marketing, standardization.....	226-227	Crops—	
		area, 1949.....	35

	Page		Page
Crops—Continued		El Yunque Project	72
area, production, and yield, 1950-51	194	Electric service—	
nonexport, production	34	May 31, 1951	81
price and value, 1950-51 and proposed	216	revenues	70
principal, production, price, and value, 1950-51	181-184	rural	81-83
production, proposed	195	<i>See also</i> Power, hydroelectric.	
<i>See also</i> under specific names.		Employment—	
Cucumbers, production, proposed	195	farm, seasonal, 1946-51	11, 16
Cultural characteristics	11-12	increase	44
		<i>See also</i> Labor.	
Dairy, definition	230	Equipment, farm, excise taxes, 1951	268
Dairying—		Erosion—	
expansion	34-35, 42, 163, 180, 212-213, 266-267	beach, problem	58
<i>See also</i> Milk production.		control, research	64
Dam—		soil—	
building	56	acreage	46
Yauco, completion	142	problem	45-64
Dams, Caonillas and Dos Bocas, capacities	72	Espiritu Santo coastal area, irrigation project	72
Dasheens—		Excise taxes, farm machinery and supplies, 1951	268
area, production, and yield, 1950-51	194	Expenditures—	
culture	203	Federal Department of Agriculture, 1942-52	272
price and value, 1950-51 and proposed	216	Puerto Rican agricultural agencies, 1941-52	273
production—		Exports, production, emphasis	36
price, and value, 1950-51	182	Extension work, strengthening	272, 274-277
proposed	195		
Death rates	7-8	Farm—	
Department of Education, projects	282-283	land, use, 1950 and 1940	35
Department of Health—		mortgage insurance	155-156
milk statistics	230-231	output, value, 1950-51	181, 182
water pollution studies	91-93	prices, 1950-51	182
Diet, problems	187-188, 189, 215-216	production, 1950-51	182
Disaster loans	155	products—	
Diseases, communicable, prevalence	8, 20, 93	marketing	219-246
Doves—		production, price and value, 1950-51	182, 184
census	98	tenure, changes, 1910-50	33
gun pressure, 1950	98	units, Isabela Irrigation District	71
Drainage, problems	95-97, 148-150	Farm Credit Act of 1933, extension to Puerto Rico	152-153
Droughts, 1944-48, relief programs	40	Farmers Home Administration—	
Dwelling units, construction, inadequacies	19-20	programs	145-146, 153-156, 163, 164, 167-168
		veterans preference loans	167-168
Economy—		Farming, technology	176-181
agriculture's role in	31-32	Farms—	
lack of balance and diversity	42-44	family-type—	
recovery programs	37-39	Lajas Valley	144-145
summary	1-4	loans	167-168
Education	12-14	program	145-146, 251-252, 259-261
agricultural, short courses	280-283	number and size, 1950	261
conservation	61-63	proportional-profit—	
Department of, projects	282-283	land use, 1952	254
formal, in agriculture	279-283	profit distribution, 1944-51	255
vocational, role	283	sugar production, 1950-51	252, 254
Egg products, requirements and supply, 1950-51	187	Fats—	
Eggs—		imported, volume and value, 1950-51	185
imported, volume and value, 1950-51	185	requirements and supply, 1950-51	187
price and value, 1950-51 and proposed	216	Federal Crop Insurance Corporation	168-170
production—		Federal Department of Agriculture—	
price, and value, 1950-51	182, 184	expenditures in Puerto Rico, 1942-52	272, 273
proposed	195	research	63
<i>See also</i> Poultry industry.			
requirements and supply, 1950-51	187		

	Page
Federal Experiment Station, research on—	
complementary crops	211
conservation problems	63
pasture crops	134
Federal Water Pollution Control Act	92
Feed concentrates for livestock	129
Feedstuffs, imported, volume and value, 1950-51 ..	184,
	185
Fertilizers	48-49
cooperative buying	166
for grasslands, studies	130
Finance, agricultural, and credit	151-174
First Organic Act, enactment	247
Fish—	
imported, volume and value, 1950-51	185
requirements and supply, 1950-51	187
Fisheries—	
inland, resources	100-102
marine, commercial	100
Flood control	94-95
Flour, requirements and supply, 1950-51	187
Fodder, imported, volume and value, 1950-51	185
Food—	
available for consumption, 1950-51	187
handling methods	221, 227
production—	
credit programs	156-157
relation to requirements	187-190, 217
stores, retail, status	219
<i>See also</i> Nutrition.	
Foods, imported, volume and value, 1950-51	185
Foodstuffs—	
imported, volume and value, 1950-51	185
production, relation to population	191
Forage—	
crops, land in proportional-profit farms, 1952 ..	254
lands, improvement	121-123
Forest—	
land, public, acquisition and benefits	112-116
lands, condition	103-105
recreation facilities, needs	117-118
resources—	
abuse	105-107, 111-112
conservation	111, 112
Foresters, training	107-108
Forestry—	
education and research needs	107-111
for landowners	116-117
Forests—	
land for	103-118
resources, use, research	107-111
4-H Clubs, activities	61-62
Freight rates, study	228-229
Fruits—	
culture	197-201
imported, volume and value, 1950-51	185, 186
processed, imported, value, 1950-51	186
production, price, and value, 1950-51	182, 183
requirements and supply, 1950-51	187
<i>See also</i> under specific kinds.	
Gardens, home, encouragement	184, 189-190
Geography	3
Goat meat production—	
price and value, 1950-51	182
proposed	195
Grains—	
imported, volume and value, 1950-51	185
production, price, and value, 1950-51	182, 183
Grapefruit—	
area, production, and yield, 1950-51	194
culture	199
price and value, 1950-51 and proposed	216
production—	
price and value, 1950-51	182
proposed	195, 199
<i>See also</i> Citrus fruits.	
Grasses, silage, use	127-129
Grassland resources, utilization	119-135, 211
Grasslands—	
management	129-133
research and education	126-127, 133-135
Grazing—	
forest land	105, 107
systems, recommended	131-132
Ground water resources	87-89
Guajataca Reservoir, storage capacity	67, 70
Guayabal Reservoir—	
sedimentation	54-55
storage capacity	67
Guineo Reservoir, storage capacity	67
Hay, imported, volume and value, 1950-51	185
Health, Department of—	
milk statistics	230-231
water pollution studies	91-93
Hides, wastage and quality	234
Hohenheim system of grazing	132
Honey, production, price, and value, 1950-51	182
Houses, construction, inadequacies	19-20
Hunting, kill data	98
Hurricane insurance, coffee	42
Hurricane Relief Commission	161
Hurricanes, damage to crops	2, 36
Imports—	
agricultural, dependence on	184-187
shortages, World War II	40-41
Income—	
distribution, 1946-51	17-19
urban and rural, 1949	17
Industrial—	
expansion	43-44
wastes, research	92, 93
Insurance—	
crop program	168-170
farm mortgage	155-156
hurricane	42
Interest rates	158-160

	Page		
Irrigation.....	67-78	Legumes—	
areas, additional.....	71-73	production, price, and value, 1950-51.....	182, 183
assessments.....	71	requirements, 1950-51.....	187
research, focal points.....	76-78	use in pasture improvement.....	123-127
system, plan.....	147-148	Loíza-Río Grande drainage project.....	139-140
Isabela Irrigation Service.....	67, 70-71, 73-74, 80	Lettuce, production, proposed.....	195
		Life expectancy at birth, 1910-50.....	7
Jute bags, cost and use.....	239-240	Literacy.....	12-14
Korean hostilities, effect on sugar production.....	42	Livestock—	
La Plata River coastal area, irrigation project.....	72	industry.....	162-163
La Regadera drainage project.....	146-148	marketing.....	233-235
Labor—		products—	
distribution, 1950-51.....	15	price and value, 1950-51 and proposed.....	216
farm, proportional-profit distribution, 1944-51.....	255	production, price, and value, 1950-51.....	181,
structure.....	14-17	182, 183	
sugarcane—		production, proposed.....	195
crop, requirements, and costs.....	256	Living conditions, rural.....	19-22
farms, 1946-51.....	17	Loans—	
unions, agricultural, operations.....	17	agricultural, sources.....	152-158
<i>See also</i> Employment.		<i>Central</i>	157, 158, 159, 160
Lajas Valley development project.....	140-146	crop.....	157-158
Land—		Federal, programs.....	37, 40
capability, classification.....	47-48, 52, 122	rural, electrification.....	81-82
classification (Land Authority).....	253	Loíza River coastal area, irrigation project.....	72
control by Land Authority, 1952.....	253	Lunches, school, program.....	22, 272
distribution by land capability classes.....	48		
farm, use, 1950 and 1940.....	35	Machinery, farm, excise taxes, 1951.....	268
for forage, improvement.....	123	Manatí River coastal area, irrigation project.....	72
for forests and tree crops.....	103-118	Mangoes—	
for pasture, research.....	121-123	area, production, and yield, 1950-51.....	194
forest. <i>See</i> Forest land.		culture.....	199-200
holdings—		price and value, 1950-51 and proposed.....	216
corporate, court decision.....	248	production—	
corporate, limitation.....	257	price and value, 1950-51.....	182
distribution and size, 1950.....	33	proposed.....	195
monopoly, prevention.....	247-248	Maps.....	II, 3, 29, 115, 138
new, development by reclamation.....	137-150	Marketing—	
policy—		needs.....	224-230
and Land Authority.....	257-262	<i>See also</i> Cooperative marketing.	
and taxation.....	247-269	Markets—	
shaping.....	247-250	central, recommendations.....	224-225
problems.....	27-44	municipal, operations.....	224
reclamation, by drainage, study.....	148-150	Marriage rates.....	7
relation to people.....	1-4, 34	Matrullas Reservoir, storage capacity.....	67
settlement, history, summary.....	1-4	Meat products, imported, volume and value, 1950-51.....	185
sloping, cultivation.....	50-51, 54	Meats—	
tenure. <i>See</i> Tenure, land.		imported, volume and value, 1950-51.....	185
use—		marketing.....	233-235
best.....	43-44	production, price, and value, 1950-51.....	182
proportional-profit (Land Authority).....	254	requirements and supply, 1950-51.....	187
uses.....	32-36	Mechanization, trends.....	176-181
Land Authority—		Medical care, problems.....	22
land policy.....	257-262	Melanía Reservoir, storage capacity.....	67
operations.....	252-257	Milk—	
Land Law.....	250-252	imported, volume and value, 1950-51.....	185-186
Lands, submerged, reclamation.....	149	marketing and distribution.....	230-233
Language problem.....	13-14	price and value, 1950-51 and proposed.....	216
Law 211.....	59-61	production—	
Legislation, agricultural credit.....	172-174	price, and value, 1950-51.....	182, 184
		proposed.....	195, 211-213
		<i>See also</i> Dairying.	

	Page		Page
Milk—Continued		Personal property mortgage law	174
products—		Pigeonpeas—	
imported, volume and value, 1950-51	185-186	area, production, and yield, 1950-51	194
requirements and supply, 1950-51	187	price and value, 1950-51 and proposed	216
Molasses—		production—	
production—		price, and value, 1950-51	182
and price, 1951	240	proposed	195
price and value, 1950-51	181, 182	Pigeons, gun pressure, 1950	98
research	278	Pineapple—	
Monopolies, land, prevention	247-248	canned, importation	186
Mortgage—		industry	42, 180, 267
insurance	155-156	Pineapple Institute of Puerto Rico, proposed	242
personal property, law	174	Pineapples—	
National Farm Loan Association of San Juan, organization, 1950	152	area—	
Nutrition—		1949	35
level	22-24	owned by Land Authority, 1952	253
problem	187-190	production, and yield, 1950-51	194
<i>See also</i> Food.		land in proportional-profit farms, 1952	254
Nuts—		marketing	240-243
imported, volume and value, 1950-51	185	price and value, 1950-51 and proposed	216
requirements and supply, 1950-51	187	production—	
Oils—		improvements	163-164, 180, 200-201
imported, volume and value, 1950-51	185	price and value, 1950-51	181-182
requirements and supply, 1950-51	187	proposed	195
Onions, production, proposed	195	Plantains—	
Oranges—		area, 1949	35
area, production, and yield, 1950-51	194	area, production, and yield, 1950-51	194
price and value, 1950-51 and proposed	216	price and value, 1950-51 and proposed	216
production—		production—	
price, and value, 1950-51	182	price and value, 1950-51	181, 182
proposed	195, 198-199	proposed	195
<i>See also</i> Citrus fruits.		Pollution, water, control	91-93
Ornamentals—		Population—	
commercial possibilities	211	annual increase, 1899-1950	5
production, price, and value, 1950-51	182, 184	aqueduct districts, 1940, 1950	83, 84
value, 1950-51	182, 184	composition, 1899-1950	6-7
Oxen, on farms, 1930, 1940, 1950	177	density, selected countries	25
Pasteurizing plants, daily output	230	distribution, by age, 1899-1950	6
Pasture—		effect of increased crop yields	214-218
acreages, desirable, estimation	122	English-speaking, 1899-1950	14
land in proportional-profit farms, 1950	254	growth, 1899-1950, and projected, 1970	6
lands, research	121-123	migration—	
supplements, use	127-129	course	9-11
Pastures—		from Puerto Rico, 1910-51	10
improvement with legumes	125-127	problems	5-26
management	129-133	relation to—	
permanent, land in proportional-profit farms, 1952	254	food supply	191
research	133-135	land	1-4, 34
Patillas Reservoir, storage capacity	67	rural—	
People. <i>See</i> Population.		1899, 1920, 1950	9
Peppers—		vs. urban	24-26
area, production, and yield, 1950-51	194	urban, 1899, 1920, 1950	9
price and value, 1950-51 and proposed	216	Pork, production—	
production—		price and value, 1950-51	182, 184
price and value, 1950-51	182	proposed	195
proposed	195	Potatoes—	
		imported, value, 1950-51	186
		production, expansion	211, 221
		Poultry—	
		industry—	
		status and outlook	163, 213-214
		<i>See also</i> Egg production.	

Poultry—Continued	Page	Research—Continued	Page
meat—		extension, needs.....	272
price and value, 1950-51 and proposed....	216	fertilizers, needs.....	130
production, proposed.....	195	grasses and legumes.....	126, 133-134
production, price, and value, 1950-51.....	182, 184	industrial, waste.....	92, 93
requirements and supply, 1950-51.....	187	insects and diseases in pastures.....	133
Power—		molasses.....	278
electric, generation, 1935-52.....	81	pasture and forage crops.....	126, 133-135
hydroelectric.....	78-83	processing agricultural products.....	229-230
annual production.....	72-73	soil erosion.....	64
development.....	54	vanilla production.....	211
income.....	71	water storage, underground.....	78
plants and reservoirs, 1952.....	80	water supply and utilization.....	77-78, 89
<i>See also</i> Electric service.		Reservoirs—	
Prices, farm, 1950-51.....	182	sedimentation.....	54-58
Production, agricultural, potentials.....	175-218	supplying water for irrigation, 1950.....	67
Production and Marketing Administration, study		Rice—	
of marketing needs.....	224	area, 1949.....	35
Production Credit Association, loans....	153, 163, 164-166	area, production, and yield, 1950-51.....	194
Products, main, and producing areas, map.....	II	enriched, legislation.....	24
Public Irrigation Law.....	69, 148	price and value, 1950-51 and proposed.....	216
Puerto Rico Department of Agriculture—		production—	
family-type farms.....	145-146	price and value, 1950-51.....	182
services.....	52, 273-274	proposed.....	195, 206-207
Puerto Rico Experiment Station—		requirements and supply, 1950-51.....	187
credit studies.....	159	River basins, drainage surveys.....	92
projects.....	134, 284	Road construction, needs.....	227-228
research.....	63, 126, 130, 134, 143-144, 229	Rum industry, growth.....	39
role.....	277-279	Rural—	
substation farm.....	140	electrification.....	81-83
Puerto Rico Extension Service—		<i>See also</i> Electric service.	
credit education program.....	171	living conditions.....	19-22
educational work.....	274-277	Rural Electrification Administration, projects.....	81, 82
forest-nursery stock, distribution.....	111	San Juan, water use, daily per capita.....	85
soil conservation work.....	59, 61	Sanitation problems.....	20-21, 91-92
working agreements.....	274, 283	School—	
Puerto Rico Forestry Service, inventory.....	103-104	enrollment—	
Puerto Rico Sugar Act.....	236	1899-1950.....	12
Puerto Rico Utilization of the Water Resources,		1950.....	280
creation, 1925.....	78	system, conservation education.....	62
Pumpkins—		School of Agriculture, curriculum and short	
area, production, and yield, 1950-51.....	194	courses.....	272, 280-283, 284
price and value, 1950-51 and proposed.....	216	School of Medicine, research.....	92
production—		Sedimentation of reservoirs.....	54-58
price and value, 1950-51.....	182	Sewage disposal, needs.....	94
proposed.....	195	Silage, use.....	127-129
Rainfall, amount.....	4, 31, 65, 74, 146, 148-149	Slaughterhouses, operations.....	234
Reclamation—		Slopes, cultivation.....	50-51, 54
areas, existing and proposed, map.....	138	Snapbeans, production proposed.....	195
areas, possible.....	138, 148-150	Social groups, classification.....	12
value in developing new land.....	137-150	Social Programs Administration, projects.....	251, 277
Reconstruction Administration.....	58-59, 153, 248-249	Soil—	
Recreation.....	97-102	conservation districts.....	58-61
rural, activities.....	21	erosion. <i>See</i> Erosion, soil.	
Reforestation, benefits.....	118	fertility.....	48-49
Refrigeration, needs.....	268	losses, effects.....	51
Refrigerators, excise taxes, 1951.....	268	organic matter.....	49-50
Research—		present condition.....	45-48
basic, to conservation.....	63-64	Soil Conservation Act of 1935.....	58
coffee growing.....	64, 109-111	Soil Conservation Committee, membership.....	59
Department of Health.....	92-93	Soil Conservation Districts Act.....	59-61

Soil Conservation Service—	Page	Sweetpotatoes—Continued	Page
operation.....	58-59, 77, 97, 102	price and value, 1950-51 and proposed.....	216
work.....	110, 116, 122, 134	production—	
Soils—		price, and value, 1950-51.....	182, 183
classification.....	46-48	proposed.....	195, 202
productivity.....	46		
research, needs.....	64	Taniers—	
saline, reclamation.....	149-150	area, 1949.....	35
South Coast Irrigation District.....	67, 68-70, 74	area, production, and yield, 1950-51.....	194
Southwestern Puerto Rico Project, extent.....	72,	price and value, 1950-51 and proposed.....	216
	79, 80, 140-146	production—	
Soybeans, imported, volume and value, 1950-51.....	185	price and value, 1950-51.....	182, 183
Spaniards, agrarian economy.....	1, 27-28, 151	proposed.....	195
Spices, imported, volume and value, 1950-51.....	185	Tax—	
Squash—		policies and land.....	247-269
area, production, and yield, 1950-51.....	194	policy, relation to agriculture.....	262-269
price and value, 1950-51 and proposed.....	216	water, 1914, and later.....	70
production—		Taxes, excise, farm machinery and supplies, 1951.....	268
price, and value, 1950-51.....	182	Technology in farming.....	176-181
proposed.....	195	Telephone service, needs.....	227
Sugar—		Temperature, annual, range.....	3-4
exports, 1828-62.....	28	Tenure—	
imported, volume and value, 1950-51.....	185	farm, changes, 1910-50.....	33
industry—		land—	
development, incentives.....	262, 263-264	and usage.....	32-36
operations, analysis.....	255	problem.....	248-250
mills. <i>See Centrals.</i>		programs.....	251
payments.....	40, 53-54	Tiburones drainage project.....	138-139
production—		Tobacco—	
for export, 1533, 1582.....	27	area, 1949.....	35
for export, 1912.....	29, 41-42	area, production, and yield, 1950-51.....	194
proportional-profit farms, 1950-51.....	254	crop insurance.....	170
purchase programs, 1942-47.....	40	exports, 1828-62.....	28
quotas, suspension, 1942-47.....	187	loans.....	158-160, 161
requirements and supply, 1950-51.....	187	marketing—	
yield increase by irrigation.....	70	cooperative.....	159-160
Sugar Act.....	30, 38-39, 40, 41, 42, 53-54, 235-236, 262	importance.....	243-246
Sugarcane—		price and value, 1950-51 and proposed.....	216
area—		production—	
1949.....	35	expansion.....	30-31
not harvested, 1950-51.....	194	price and value, 1950-51.....	181, 182
owned by Land Authority, 1952.....	253	proposed.....	195
production, and yield, 1950-51.....	194	Tobacco Marketing Cooperative Association, loans.....	159-160
cooperative services.....	161, 166	Tomato paste, imported, value, 1950-51.....	186
farms, labor, 1946-51.....	17	Tomatoes—	
harvested, labor requirements and costs.....	256	area, production, and yield, 1950-51.....	194
land in proportional-profit farms, 1952.....	254	price and value, 1950-51 and proposed.....	216
loans.....	158-159, 160-161, 166	production—	
marketing.....	235-240	price, and value, 1950-51.....	182
on slopes, problem.....	51-54	proposed.....	195, 210
price and value, 1950-51 and proposed.....	216	Topography.....	3, 31
production—		Tractors on farms, 1930, 1940, 1950.....	176, 177
and value, Lajas Valley.....	140	Transportation systems, inadequacy.....	227-228
importance.....	193-196	Tree crops, land for.....	103-118
labor requirements and costs.....	256		
mechanization.....	179-180	U. S. Supreme Court decision on corporate land	
price and value, 1950-51.....	181, 182	holdings.....	248
proposed.....	195	United States—	
Sweetpotatoes—		sovereignty, effects.....	29-31
area, 1949.....	35	<i>See also Federal.</i>	
area, production, and yield, 1950-51.....	194	University of Puerto Rico, programs.....	279-280
culture.....	201		

	Page		Page
Vanilla production, problems.....	211	Water Pollution Control Advisory Board.....	91
Veal—		Water Resources Authority—	
price and value, 1950-51 and proposed.....	216	electric power.....	72, 79, 80, 82-83
production, proposed.....	195	flood control work.....	95
Vegetable industry, commercial, establishment.....	144	functions.....	56-57, 81, 89, 99, 141-142
Vegetables—		waterfowl habitats.....	99
imported, volume and value, 1950-51.....	185, 186	Water Resources Authority Act, powers.....	78-79
production—		Waterfowl—	
price and value, 1950-51.....	181-183	census.....	98
proposed.....	181, 195, 210	feeding grounds, development.....	99
requirements and supply, 1950-51.....	187	Wheat feed, imported, volume and value, 1950-51.....	185
Veterans preference on loans.....	167-168	Wildlife—	
Visual instruction, value.....	63	conservation.....	118
Wastes, industrial, research.....	92, 93	management.....	97-102
Water—		Wood, value, 1950-51.....	182
concessions.....	89-90	Workers. <i>See</i> Labor.	
consumption, urban areas, 1950-51.....	84	Working agreements.....	57, 274, 277-283
distribution in rural areas.....	85, 86	<i>See also</i> Cooperative agreements.	
ground, resources.....	87-89	World War I, economic effects.....	36-37
management, problems.....	73-76	World War II—	
output, aqueduct districts, 1950-51.....	84	economic effects.....	39-41
pollution.....	21, 90-94	postwar developments.....	41-42
rights.....	89-90	Yams—	
supply—		area, 1949.....	35
and utilization, research.....	77-78, 89	area, production, and yield, 1950-51.....	194
aqueduct districts.....	84	price and value, 1950-51 and proposed.....	216
domestic.....	83-90	production—	
industrial.....	83-90	possibilities.....	202-203
use and control.....	65-102	price and value, 1950-51.....	182
use, daily per capita, San Juan.....	85	proposed.....	195

